Electrical World

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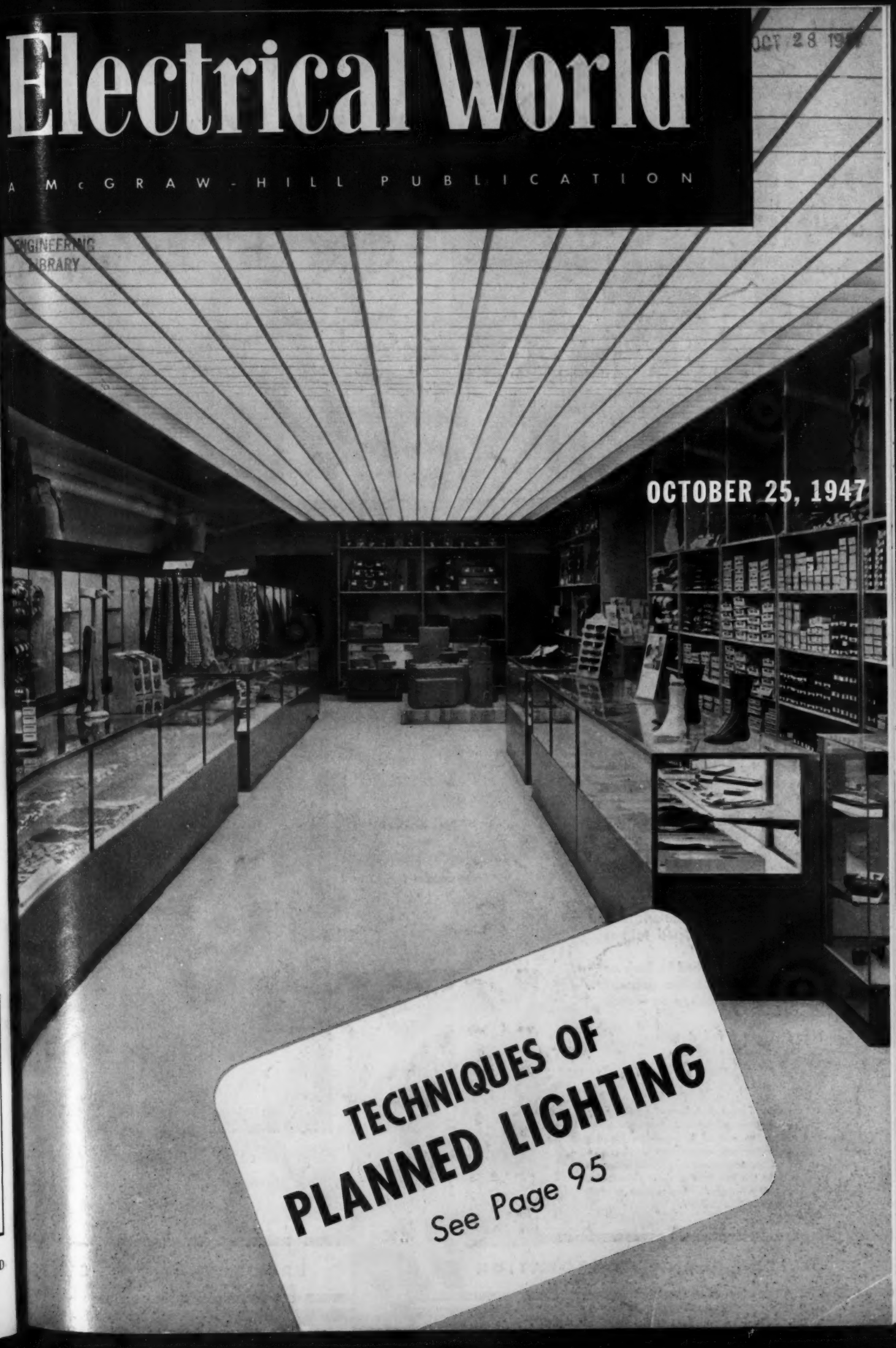

OCTOBER 25, 1947

TECHNIQUES OF PLANNED LIGHTING

See Page 95

A complete line of LOAD CENTERS

fitted with **Murray**

FULLY MAGNETIC CIRCUIT BREAKER

easier to select—simpler to install

GROUP 2—Accommodates 2 circuit breakers, changeable without wiring alterations.

GROUP 4—Accommodates from 2 to 4 circuit breakers.

GROUP 6—Accommodates from 2 to 6 circuit breakers.

These three groups of Murray Load Centers were designed to accommodate, respectively, two, four or six Magnetic Circuit Breakers in a flexible arrangement that permits replacement or addition. If present need is for but four Circuit Breakers, use a Group 4 Load Center, but if there is prospect of two additional Circuit Breakers being needed in the future, install a Group 6 Load Center of four Circuit Breakers which provides for installation of two additional Circuit Breakers later.

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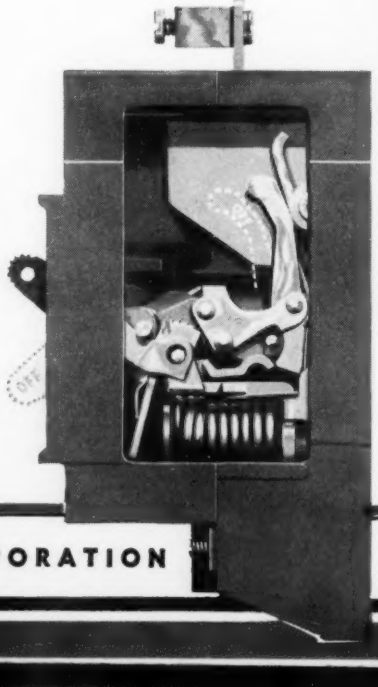
Murray Circuit Breakers are singly housed and thus interchange means replacement of only a single breaker—not a group of them. Interchange of Circuit Breakers of different amperages or additions are quickly installed and connected to bus bars.

Murray Load Centers supplied in flush or surface types. They have a fine appearance and are finished in baked-on French grey enamel.

Bulletin No. 501 gives full details.



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Electrical World

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October 25, 1947

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This Week's Cover Picture

The planned lighting installation of the George Wyman & Co store in South Bend, Ind., comprises 36 three-light, 40-w, Day-Brite industrial fluorescent units in Louverall ceiling fixtures. This installation, designed by Thomas Smith Kelly, lighting consultant in New York City, has an average intensity of 38 ft-c.

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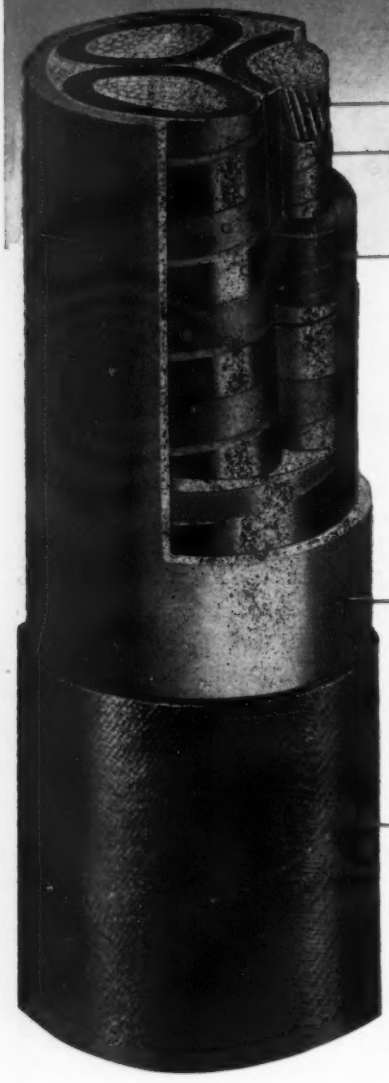
. . . insures year-after-year values in Okonite-Callender power cables



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So, when you buy on a value-first and final-economy basis, remember what Okonite-Callender paper insulated power cables offer you. Here is evidence of their step-by-step protection.

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2. **Metallized paper tape,** between conductor and insulation, keeps out objectionable products of reactions between copper and oil. Provides smooth conducting surface under insulation. Also wrapped over insulation, metallized tape maintains electrical contact with metal shielding tape or lead sheath, preventing ionization when sheath expands.

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paper-insulated power cables

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Electrical World — Editorials

OCTOBER 25, 1947

Planned Lighting and the Boss

WE DONT EXPECT any top executives of any electric utility to pore in fascinated delight over the 28 pages on the technical details of Planned Lighting in this issue of ELECTRICAL WORLD. But we do hope that some of them will take time to leaf through those pages and see what is there.

Let us tell you why we hope so, in the words of many men heading utility lighting sales. Here is a composite of them:

"Before the war we sold planned lighting. We didn't call it that, and we wouldn't have spelled it with capitals if we had. Then my men leaped or were dragged to arms or they went out and got more pay in war plants. During the war, I was the whole department. I didn't sell any lighting. I struggled with priorities, trying to get lighting equipment and materials for plants that needed them for war production.

"I knew we'd have to start selling lighting again when the war was over. I knew that the selling job would be a lot bigger than it was before. The art had advanced greatly. There would be plenty of smart boys ready to take advantage of that advance to grab off some quick profits. It would be up to us to see that our customers bought good modern lighting, not just fixtures and promises of lower electric bills.

"So I started to rebuild my department. Right at the end of the war, the boss was all steamed up about selling because he expected we'd lose a big chunk of load. He said, 'Sure, go ahead and hire some men.' But before I was able to get all the men I needed, he saw that we were not losing load as he expected and he told me to ease off. He was beginning to be worried about capacity.

"I have six men now and I have authority to add two more. But eight men can't do a real job of selling Planned Lighting over all our territory. I need at least twice as many. Yet if I went to the boss now and said I had to have, not two, but ten, more men, he'd throw me out of his office.

"There are three things the boss doesn't understand. Or maybe he does understand them, but he can't be bothered to think about them right now.

"One thing is that a great deal of the lighting sales work that should be done at present is of a protective, rather than a load-building, nature. It is, first, to protect our customers from spending money on what they think is a modern lighting installation and then finding out that all they have bought is a flock of bum fixtures. Second, it's to protect us from the loss of revenue that usually results from simple replacement of incandescent by fluorescent lighting units.

"Another thing is that immediate additional load resulting from lighting sales is not going to be very heavy in total and won't add more than a cat's whisker to the system peak. Most of it will be just substitution of juice going through fluorescent tubes instead of incandescent lamps.

"The third thing I wish the boss would think about, and it's the most important, is that if I had 18 men today, it would take a year or more to make good lighting salesmen out of them. And it would take a year or more after that for their efforts to result in much added load."

From the Planned Lighting feature in this issue of ELECTRICAL WORLD, the man in the big office will get an appreciation of the job of selling modern lighting. And then, maybe, a request for ten more men won't automatically result in the head of lighting sales being thrown out of the executive lair.

NEWS OF THE

Public Ownership Support Weak as Utility Asks Charter

Chicago City Council Begins Hearings on New Franchise for Commonwealth Edison Co but Secrecy Surrounds Terms —Utility Seems Secure because of Its Rates and Service

By Richard N. Larkin

CHICAGO—City Council began hearings this week (Oct 20) on whether to grant a new franchise to the Commonwealth Edison Co. A 50-year franchise under which the company, and its predecessors, served the city expired five weeks ago but was extended to cover the period when a new franchise is under consideration.

Many Chicagoans close to the negotiations denied overwhelmingly last week any real prospect of public ownership. It was apparent that negotiations will revolve almost entirely around new franchise terms. Neither company, city, nor other sources would discuss in any detail the probabilities of the terms.

Public ownership forces in the nation's second city, however, are active. They command some support in city council and count at least two of the city's daily papers friendly to their cause. One political figure told ELECTRICAL WORLD that public ownership proponents are attempting to devise a plan for municipalization. Their aim is to yield the city revenues at least equal to those it now obtains while insuring rate reductions at least equal to Commonwealth's net yearly earnings.

Whatever its motivation, the secrecy with which city and company surround their ideas regarding terms of a new franchise is real. Company sources declined to speak for quotation and said almost nothing off the record. City sources agreed that they were doing considerable thinking about the terms but declined flatly to go into detail. New franchise terms "which practically amount to public ownership" have been laid before City Council, one official said.

One source, closely connected with the negotiations, asserted that "the most obvious angles for rewriting the franchise are not necessarily the most important." Strangely, this seemed to apply to the 3 percent gross receipts franchise tax. Certainly, most people expect the tax to be reviewed carefully in the light of Chicago's need for greater municipal revenues. This source said also that proposals for new and less costly street lighting, while under discussion, "are not a major issue in the negotiations." Rate reductions are another obvious, but barely discussed, prospect in the negotiations.

It was apparent that the new franchise, if issued, will not be for a 50-year term.

No one seemed to know how long the franchise negotiations would take, but it was certain that they will not be completed this year. Some guessed that they might run for as much as one year more. Others insisted that they would not extend that long. Terms of the extension of the original franchise provide that changes in any new charter shall be retroactive to September 18, expiration date of the original.

Meanwhile, negotiators await an engineering report by the Kansas City firm of Black & Veatch, for which the city contracted some time ago. The report was to evaluate the Commonwealth system and to discuss the benefits, if any, which public ownership would yield the city.

One thing was plain. Those who seek public ownership will not be able to get it through the same device which turned over Chicago's transportation properties to public ownership recently. The lines were bought by the Chicago Transit Authority with the proceeds of a $105,000,000 revenue bond issue. But the legislation which set up the authority was limited purely to a transit authority—in Chicago and in 85 neighboring Cook County municipalities. Entirely new legislation would be required to set up a comparable power authority to take over the Commonwealth properties. Prospects of such

IN THE TEMPORARY office set up by the Central Vermont Public Service Corp in Rutland, Robert Van Buskirk, right, takes down the claims of a flood sufferer seeking payment under the utility's plan to make final adjustments of property losses. The floods of last June caused by the breaking of a power dam has led to damage suits of $1,500,000 against the corporation

Chicago City Council Begins Electric Franchise Hearings

CHICAGO Councilmen sought information on Commonwealth Edison Co's service and charges, on conditions of a new franchise, and on the possibilities of municipal ownership as hearings opened (October 20) on whether to issue a new franchise.

Alderman Clarence P. Wagner, chairman of Council's Public Utilities Committee, asked that testimony answer and clarify 26 points, of which six dealt with service and rates, seven with possibilities under municipal ownership, and the remainder with conditions of franchise renewal.

Alex D. Bailey, Commonwealth vice-president in charge of engineering and operation, opened the hearings with a discussion of the system's construction plans. He described a new generating station which is planned for the Sanitary Canal south of Cicero's treatment works. Its first unit of 150,000 kw is expected to be in operation in the fall of 1950. A second, similar unit is under consideration for operation a year later. The entire expansion program, Bailey testified, would add about 557,000 kw, including a new 150,000-kw machine on order for the Fisk plant and the 107,000-kw unit recently installed at Calumet.

When equipment is available, Bailey added, Commonwealth will proceed with conversion of the d-c area within the Loop to a-c. Originally, about 13 square miles were in d-c. This has been reduced to about three square miles, with about 40 percent of its energy distributed as a-c.

Assistant Vice-President J. Harris Ward testified that Chicago's rates compare favorably with those of cities where cost factors are similar. Commonwealth's rates, he said, are in the middle group of the country's largest cities. Despite this fact, he added, Commonwealth's wages and taxes per dollar of operating revenue are among the country's highest.

W. D. Gale, vice-president in charge of finance, set the cost of the five-year expansion program at $186,000,000, of which $100,000,000 would be necessary in new money. Gale emphasized that speed in arranging the financing is important because of the increases in cost of debt capital. During the last 18 months, he said, yield of high-grade utility bonds has risen from 2.25 to 2.75 percent. The new money would be obtained, Gale said, in part from new bond issues and in part from a stock issue on convertible debentures.

Otto Gressens, vice-president and comptroller, gave the only testimony touching municipal ownership questions. He said Commonwealth's tax payments last year totalled $28,320,838. Of this, he said, $10,239,036 went to city and county agencies and "would not be available under municipal ownership."

legislation are so dim as to be non-existent, informed sources agreed. Most asserted that the public ownership sentiment which such legislation would require is non-existent in Chicago today, so far as Commonwealth Edison is concerned. Practically all sources spoke highly of the company's service and public relations, and little complaint was made about its rates. There is absolutely no "public ownership crusade" against Commonwealth by important elements in Chicago.

The transit picture, prior to its take-over by the authority, was completely different, all sources agreed. The transit operation was in bad shape. Definitive action, quickly, was necessary. The transit authority was agreed upon as the most likely solution. It was not a crusade for public ownership but a demand for effective local transportation and for protection of debt capital. The act enabling the transit authority, informed sources said, was passed by the state legislature only after considerable pressure had been exerted by leaders of both major political parties. None could foresee comparable pressure for a power authority in Chicago and Cook County.

Certainly, under the terms of the transit authority legislation, there is little motivation for Chicago to seek authority acquisition of the Commonwealth properties. Under authority operation of the transit system, Chicago obtains no revenue. But the city needs revenue. It makes no sense for the city to support authority acquisition of the profitable Commonwealth properties if it would not get out of it those revenues it now receives—$3,527,000 in the year ending last May 31.

The city long has had the authority to municipalize electric service within its borders. It also has authority to issue revenue bonds for this purpose—which all agree is the only way the city could raise the money to buy Commonwealth's properties. But municipalization would require a referendum. In the absence of sentiment for public ownership of the Commonwealth properties in Chicago now, there was no feeling that such an election could be carried.

Further complicating the municipalization picture is the fact that it might take not one but perhaps three elections. The law is ambiguous, but it contains the possibility that the public might have to vote first upon acquisition, second upon operation, and third upon the revenue bond issue. The law specifically requires elections on both acquisition and the bond issue.

•

Oklahoma Public Service Buying Neighboring Utility

The Public Service Co of Oklahoma, Tulsa, will acquire control of the Oklahoma Power & Water Co as soon as the Securities and Exchange Commission gives its approval.

The sale will include stock, a generating plant at Sand Springs, headquarters of the company, substations, 231 miles of transmission lines, and all other electrical equipment. Oklahoma Power serves over 9,000 customers.

Oklahoma Power has already sold its gas properties and has a number of bidders for its water properties. When all assets have been sold, the company will dissolve.

UWU Looks Ahead with Hope at Second National Meeting

CIO Utility Workers Will Comply with Taft-Hartley Act Provisions—Union Now Has 72,000 Members and Assets of $99,549—Bans Secondary Strikes Unless Scabs Are Used

THE SECOND annual convention of the Utility Workers Union of America, CIO, in Buffalo this week could not have been more timely.

The union had just got the green light from the CIO convention a week before to qualify under the Taft-Hartley Act for use of the National Labor Relations Board if it wished.

While arrangements were being made for national and local union officers to file the necessary non-Communist affidavits, the 300 delegates talked hopefully of what this meant toward growth of the union and its ability to compete with the rival International Brotherhood of Electrical Workers, AFL.

UWU Executive Board went on record last July favoring compliance with the Taft-Hartley law "unless the national policy of CIO prohibits doing so." This was in contrast with the United Electrical, Radio & Machine Workers, also CIO, which probably will be one of the last unions to qualify under the law. At the CIO convention, James J. Matles, UE director of organization, bemoaned the fact that the united front to boycott NLRB was being broken by individual unions. His charge that union organization has "gone down to a snail's pace" since passage of the Taft-Hartley law was denied by CIO President Philip Murray, who replied from the chair that the new labor law has not stopped the growth of the CIO and will not stop it.

Officials of UWU were studying means of protecting its interests in California if some local union officials refuse to comply with the law and are thereby denied NLRB facilities. They are particularly concerned about Pacific Gas & Electric Co, where the UWU has been having a struggle with IBEW. If the local union officials don't comply with the law, the parent union may boycott the local and itself deal directly with management.

UWU received a report from its officers showing a net gain of $70,730.93 of income over expenses during 15 months following the last convention in Atlantic City in April, 1946. Total assets as of June 30 were reported as $99,549.

The union carries 34 field representatives, who have assisted in the chartering of 30 new locals. It claims to have contracts covering 72,000 workers in utilities and boasts an additional 3,000 members in plants still under organization.

The officers' report discloses adoption by the Executive Board of a policy of crossing picket lines thrown around utility plants by other unions in order to force a sympathy strike against struck plants being serviced by the utility. The only exception is when the primary employer has taken on non-union workers in order to beat the strike.

"It was decided that all our contracts should be lived up to by our members and that light, power, gas, steam, and water should be supplied to all customers even though a strike was taking place at one of these customer's place of business except when scab labor was being used to deprive the regular employees of their jobs," the policy statement reads.

The Executive Board, last July, also adopted a standard wage and negotiation policy. This included a second-round wage increase demand of 35 cents an hour. Local unions were also urged to request a cost-of-living reopening clause in each contract, a termination date near March 1 each year, and the incorporation of existing pension plans in the contracts.

•

Duquesne Union Gets Set for Higher Pay Demands

The cost of living—which has been causing trouble for everyone—brought the threat of a new wage boost demand to the Duquesne Light Co this week. (October 12).

President George L. Mueller of the independent union representing Duquesne workers told ELECTRICAL WORLD that a wage demand—which he would not define—would be served on the company as soon as the U. S. Bureau of Labor Statistics released figures showing that the cost of living in Pittsburgh has risen 10 points above a base figure of 153.

Under an arbitration award filed earlier this year, a fluctuation of 10 points in Pittsburgh's cost of living index—up or down from the base figure of 153—enables either side to open the contract for a wage boost or cut. Mueller said the BLS figures for Pittsburgh for July 15 stood at 162.6. The August 15 figure, which was to be released late this week by BLS, was expected to stand at 164.9, Mueller said. If it passes 163, he went on, the request for a re-opening of the contract and a new wage increase will be made immediately.

Mueller said that under the arbitration award, the contract could be reopened only for a wage boost or decrease. The arbitration award granted wage increases ranging from 5 to 18 cents hourly.

•

PPD Adds 2 Systems

The Consumers Public Power District, Columbus, Neb., has bought the electrical distribution systems of Eddyville and Richland. The two towns have been buying power wholesale from the PPD.

The Nation's Power Supply

Significant facts learned by a committee of the electric industry's power experts in a survey sponsored by the Edison Electric Institute:

For the country as a whole, there will be a 5 percent average margin of reserve generating capacity for this winter's peak demand.

Total peak power demand in December is expected to be about 49,000,000 kw.

Capacity is now growing faster than load.

Installation of new generating capacity is now proceeding at the rate of 400,000 kw a month.

From 1947 to 1951, 18,000,000 kw of new capacity will be added; 15,500,000 kw will be steam units.

Business-managed utilities will add 15,000,000 kw of this.

For 1948 the country-wide average margin of reserves of generating capacity over peak demands will be about 8 percent.

UUU Dissolves and Locals Favor Affiliation with CIO

Federation of Independent Unions, Led by George Mueller, Duquesne Light, Takes His Advice to Disband—Move Ascribed to New Legislation Making National Support Necessary

A MINOR but substantial realignment of unions representing electric utility labor was in progress this week after the formal dissolution of the United Utility Unions of America, a loose federation of independents.

Ex-President George L. Mueller of the Triple U told ELECTRICAL WORLD this week, (October 21), that the nine or more independent unions which made up the Triple U were unanimous against affiliating with the International Brotherhood of Electrical Workers, AFL. Almost all of them, Mueller added, favored affiliating with the Utility Workers of America, CIO. For various technical reasons, Mueller went on, it may be some time before some of them actually do affiliate.

Mueller, who is president of the Independent Association of Employees of the Duquesne Light and Affiliated Companies, said that he recommended to his membership that it affiliate with the UWU-CIO. He added that there was not a single dissenting comment upon his recommendation and indicated a feeling that such affiliation would be approved overwhelmingly when it is submitted to a vote. Mueller explained that no vote would be taken by the Pittsburgh utility workers until UWU-CIO had filed all necessary registration papers with the National Labor Relations Board—including the highly controversial anti-Communist affidavits required of union officials.

UWU-CIO is expected so to qualify within two weeks.

Dissolution of the Triple U was accomplished October 11 at St. Louis, on Mueller's recommendation. Represented at the meeting were independent unions of workers at Pennsylvania Power & Light Co, Kansas City Power & Light Co, Duquesne Light Co, Boston Edison Co, and Gulf States Utilities Co. Unrepresented at St. Louis, but members of the Triple U, were independents representing workers of Potomac Electric Power Co and Indianapolis Power & Light Co, and certain salaried employees of Detroit Edison Co and Wisconsin Power & Light Co, Mueller said.

Mueller ascribed the dissolution of Triple U to the enactment of state and federal legislation regulating unions. Not only was the Taft-Hartley law enacted, but in every state in which a Triple U affiliate operated, state laws regulating labor were enacted.

As a result of these legislative restrictions, Mueller explained, the Triple U leadership became convinced that a drive to break up national unions is in full swing. This conviction, Mueller went on, led executives of Triple U affiliates to believe that they could best resist the drive by affiliating with a national union.

Mueller also explained why sentiment at St. Louis was unanimously against affiliation with IBEW-AFL. Triple U was originally organized in 1939, he said, in an effort to establish a national organization representing every utility employee.

In those days, he said, the CIO had only the United Electrical Workers, a union of manufacturing employees, while the AFL had only IBEW, which then did not represent utility employees.

Since then, Mueller said, the UWU-CIO has been organized to represent utility workers alone, while IBEW-AFL has confined its utility members to one division of the entire union. The fact that UWU-CIO offers what the Triple U founders originally sought led to the preference for the UWU-CIO.

Actually, there are additional bonds between UWU-CIO and the independents who made up the Triple U. Joseph A. Fisher, president of the UWU-CIO, formerly was president of an independent union representing Consolidated Edison Co, employees. UWU-CIO was organized when Fisher led his strong independent into the CIO some years ago. Combined with the utility Workers Organizing Committee, a CIO affiliate, the New York independent became the nucleus of the UWU-CIO. It was rumored at the time, without verification from Mueller, that a dispute as to presidency of the newly formed UWU-CIO kept the Duquesne Light independent, headed by Mueller, from affiliating with the new CIO union.

Mueller told ELECTRICAL WORLD this week that he has not discussed the possibility that he will hold national office with the UWU-CIO when his Duquesne independent joins.

LEADERS in the Chicago Electric Association's "Fall Salute to Electrical Living" make final check of prizes offered in $10,000 contest. Left to right are Felix Van Cleef, association president; E. M. Ball, Commonwealth Edison Co; and Axel H. Kahn, General Electric Supply Corp

Arizona Gets Aid

Arizona's power shortage is being greatly alleviated by 50,000 kw of Parker dam power being supplied by California utilities. The added supply from California, is permitting the state's power needs to be met in the most part without curtailment. Some 25-cycle areas are still in difficulty. An extreme water shortage has curtailed power production in Arizona for nearly a year.

If We Believe in America First, Europe Will Get Little Heavy Power Equipment

If we are guided by our own needs, comparatively little heavy power equipment will go to Europe as Marshall Plan aid during the next two years. That is the principal conclusion of Interior Secretary Krug's report to the President on national resources (What we have) (Electrical World, September 27, Page 44; October 4, Page 3).

However, two forthcoming documents, the Harriman report (What we can spare), and the Nourse report (How much we'll be hurt), will detail the equipment which may be exported.

Power aspects of the Krug report deal with domestic requirements and manufacturing capacity. The conclusions:

1. For two years at least, domestic generating equipment demands will equal, if not exceed, production.

2. After 1949, production of generating facilities equipment will exceed national requirements by 500,000 to 1,000,000 kw yearly.

The report also estimates that power supply will be tight until 1950. It predicts no national "power famine," however. These conclusions assume "continuing high employment and production."

Manufacturers' estimates appear optimistic compared with production of stationary equipment during the war (see table).

These estimates anticipate that shop capacity built during the war for marine and special equipment will become available for turbo-generator construction. The report assumes that actual production is "unlikely" to exceed 75 percent of the manufacturers' estimates, "without government scheduling and control."

The report also implied a need for government control of the distribution of finished equipment. It said: "To the extent . . . possible . . . careful examination should be made of the destination of such equipment in order that it may be installed where it will make the greatest contribution. . . .There is also the possibility that a similar choice may be indicated over the next five years between those areas of the United States where additional equipment may be needed to relieve production bottlenecks and . . . for reserve purposes."

Production of Generating Equipment in the United States

Year	Steam	Hydro	Int. Com.	Total
1942 (actual)	2,427,000*	650,000	300,000	3,377,000
1943 "	1,846,000	1,000,000	326,000	3,162,000
1944 "	1,820,000	750,000	410,000	2,980,000
1947 (est.)	3,920,000	1,480,000	410,000	5,810,000
1951 "	5,270,000	1,550,000	550,000	7,370,000
1952 "	5,295,000	1,600,000	550,000	7,445,000

* Kilowatts

Holding Company Act Now Legal—Last Case Closed

The Supreme Court this week finally disposed of the last major legal challenge to administration of the Public Utility Holding Company Act of 1935.

Two cases involving Section 11 (b) (1) of the act — Securities and Exchange Commission vs. Engineers Public Service Co. and Engineers vs. SEC —has been pending before the court since 1943. They were closed when the court remanded the cases to the District of Columbia Court of Appeals with direction to dismiss the petitions for review. The high court took cognizance of Engineers' compliance with a five-year-old order by SEC to divest itself of some $30,000,000 of properties.

The court at its last session upheld the validity of Section 11 (b) (2), the "death sentence" clause, and SEC's administration thereof in cases involving American Power & Light Co and Electric Power & Light Co.

Delay in reaching a decision on the Engineers' cases was attributed to the court's inability to obtain a quorum. At one time three justices disqualified themselves from the proceedings. In this week's action, Chief Justice Vinson, a member of the District of Columbia Court when the cases were argued there, and Justice Douglas, former SEC Chairman, took no part.

•

Named To Commission

Richard Mack, Coral Gables business man, has been appointed by Gov. Millard Caldwell as a member of the Florida Railroad and Public Utilities Commission to succeed the late W. B. Douglass. He will take office immediately and will run for reelection next year.

Seymour Will Carry On Present Power Programs

No major policy change is expected to result from the recent shift in the Interior Department's Division of Power.

Walton Seymour, chief of Interior's new Program Division, who also has assumed direction of the Power Division, said that for the present, at least, he would carry on the present programs of the power unit.

Seymour replaces Arthur E. Goldschmidt, who had supervised the department's power staff since 1942. The latter has been appointed vice-chairman of the Interdepartmental Technical Committee which is planning an International Conference on natural resource utilization and conservation for the Economic and Social Council of the United Nations. The appointment was made by Interior Secretary Julius Krug, who is chairman of the Interagency Committee.

UN's resources conference will bring together scientists, technicians and administrators working on conservation programs in many countries. The Krug committee will organize the United States delegation.

•

July Energy Output Set Record High for Month

Production of electric energy by electric utilities during July totaled 20,781,955,000 kwhr and again reached a new high for the month, the Federal Power Commission reports. This is the eleventh consecutive month in which production has set a record high over the same month in preceding years. This July's production was an increase of 11.6 percent over July, 1946, and 2.7 percent above the 20,243,817,000 kwhr in June, 1947. Combined utility and industrial production was 24,937,531,000 kwhr during July, 1947, an increase of 10.4 percent compared with July, 1946.

Production of electric energy by water power in July, 1947, amounted to 6,546,253,000 kwhr or 31.5 percent of the utility total, in comparison with 34.5 percent of the total output in July of last year.

•

100,000-Kw Unit Ordered

Alabama Power Co has placed an order with the General Electric Co for a 100,000-kw electric generator for installation in either the Gadsden or Gorgas steam plant.

Wisconsin Utility and Co-op End Hydro Project Quarrel

Lake Superior District Power Co Quits Trying to Block Flambeau River Plans of Dairyland Power Cooperative and Leases 3 Plants to Co-op for 35 Years—Will Rebuy Power

THE Lake Superior District Power Co and the Dairyland Power Cooperative have made peace. The business-managed utility of Ashland will cease its efforts to block the La Crosse co-op from building a 15,000-kw hydro plant on the Flambeau River. Instead it will lease three of its own plants to the co-op and buy from it up to 40,000,000 kwhr annually.

The joint announcement by Lake Superior President Walter J. Hodgkins and Dairyland President E. J. Stoneman came just a day before the co-op dedicated a 30,000-kw steam plant at Alma.

The joint announcement said:

"We feel that the settlement arrived at is in the best interests of all concerned. We have tried sincerely to seek a practicable and sensible means of getting more needed power developed at an early date for the consumers in the area of both the company and the co-operative and to avoid further and expensive litigation and needless acrimonious controversy.

"We believe that our efforts have been successful and will form the basis for a new relationship beneficial both to the consumers of the power company and the consumer members of the cooperative."

The co-op has been trying for over a year to secure permission from the Wisconsin Public Service Commission to erect a dam on the Flambeau River and erect a power plant. Lake Superior and the Northern States Power Co have been fighting the proposal. Lake Superior had a counter proposal for a hydro project of its own at Josie Island, located in the flowage area of the proposed co-op project.

Under the peace terms, the utility will drop plans for its own project and will withdraw opposition to that of the co-op. It is now probable that Dairyland will receive PSC approval for its project without much further delay.

Lake Superior will lease its 650-kw Port Arthur plant, 1,750-kw Thornapple plant, and 1,900-kw Ladysmith plant and their dams below the proposed co-op project to Dairyland for a 35-year term beginning when the co-op dam is completed.

SEARING HEAT from the 4,700 gal of gasoline in this burning tanker melted down 12-kv primaries serving four districts of Southwestern Gas & Electric Co territory and destroyed the pole

The co-op will pay all operating costs, maintenance, and taxes as presently assessed.

Dairyland will have the right and proposes to construct major additions to the three dams to increase their capacity and the output of the plants. At the end of 35 years, the utility will have the right to buy all of the additions made by the co-op. If it doesn't wish to do this, the lease automatically continues 15 years longer.

Lake Superior will replace the energy lost by the leasing of its plants by purchasing up to a total of 40,000,000 kwhr annually with a maximum demand up to 6,800 kw.

Engineers claim that with the co-op in control of all of the plants, maximum development of the river in that area is possible, and that when additional equipment is installed at the three utility company plants, all waste of water will be eliminated. The plan also makes it unnecessary for Dairyland to build a $200,000 controlling dam below the proposed new dam.

•

N. Y. Court Denies Review of Staten Island Decision

The New York Court of Appeals has refused to review its decision that the facts underlying any Public Service Commission ruling lowering a utility company's rates could be tried in court if the company found the rates "confiscatory."

Last spring, the court by a 4-3 vote held that the Staten Island Edison Corp could go into the lower courts for an injunction to halt a rate reduction ordered by the Commission until the facts, as well as the law, had been reviewed in court (ELECTRICAL WORLD, May 21, Page 13).

The decision was interpreted as a wide departure from the long-established procedure in which court review was limited to a determination of whether the Commission had obeyed the law and given reasonable consideration to the facts.

•

VEPCO Gives Raises

Virginia Electric & Power Co has reached an agreement with the independent Utility Workers' Union on contracts for 1947-48. The clerical workers unit will receive approximately a 10 percent raise, while the technical workers will receive $10 more a month. In compliance with a state law, a maintenance of union membership clause has been eliminated from the new contracts.

N. Y. Commission Rejects Long Island Consolidation

A company-sponsored plan for the consolidation of four companies of the Long Island Lighting System into a single operating utility has been rejected by the New York Public Service Commission as being contrary to the public interest.

The companies involved are Long Island Lighting Co, the parent, Queens Borough Gas & Electric Co, Nassau & Suffolk Lighting Co, and Long Beach Gas Co. The PSC ruled Long Beach out of any consolidation program at this time because of deficiencies in its capital structure and poor earnings.

Chairman Milo R. Maltbie suggested a new consolidation plan for the utilities. His plan calls for the reduction of long-term debt from $54,000,000 to $44,000,000, the issuance of $21,000,000 in new preferred stock to pay off $10,000,000 in outstanding debentures and $10,800,000 in short term loans due this year, and the issuance of $20,000,000 of common stock in the new consolidated company to present preferred stockholders. The present common stockholders would not receive any interest in the new company.

Under the company plan, the Commission found that the long-term debt of the consolidated company would be nearly 70 percent of its net assets and over 73 percent of the value of its utility property. In addition, the plan favors preferred stockholders of Long Island Lighting over those of the other companies.

•

2 South Carolina Utilities Negotiating Merger Deal

Negotiations are in progress for the merger of South Carolina Power Co, subsidiary of Commonwealth & Southern Corp, and South Carolina Electric & Gas Co. President S. C. McMeekin, South Carolina Electric & Gas, says that such a consolidation "would provide the service areas of the two companies with the strongest power resources in the Southeast."

In the organization of the Southern Company, to take over holdings of Commonwealth & Southern in the South, the Charleston operating properties were not included and were scheduled for sale. The merger would be logical, since the two as one system would cover a large portion of the state.

Negotiations for sale of the company were first started in 1944 and have recently been resumed. All studies so far indicate the advantage of the proposed merger. Both companies are interconnected and there are interconnections with Georgia Power Co, Duke Power Co, Carolina Power & Light Co, and the Santee-Cooper plant near Moncks Corner.

A short time ago Santee-Cooper public power authority sought to purchase South Carolina Power, but is without the necessary authority to consummate such a deal. Indications are that if an outright purchase is made by the Columbia utility, new financing would be necessary, unless a stock exchange arrangement could be effected.

•

Some Up, Some Down

Pay rises totalling $1,092,000 annually for 4,646 Los Angeles City Department of Water and Power employees have been granted by the Board of Water and Power Commissioners. The raises were based on results of a Jacobs Wage Survey which reevaluated all departmental employees' duties. Lower pay was recommended for 3,125 other employees by the survey, but no pay cuts were ordered. Vacancies in the jobs for which lower rates were recommended will be filled at the lower pay with an expected annual saving in the department of $492,000.

MEETINGS

Oklahoma Utilities Association—Western District Conference, Ione Hotel, Guthrie, Okla., October 30; Eastern District Conference, Veterans of Foreign Wars Building, Sapulpa, Okla., October 31. Kate A. Niblack, secretary, 625-626 Biltmore Hotel, Oklahoma City 2, Okla.

American Society of Mechanical Engineers—Annual Meeting, Chalfonte-Haddon Hall Hotel, Atlantic City, December 1-5. Ernest Hartford, executive assistant secretary, 29 West 39th St, New York 18, N. Y.

Previously Listed

International Association of Electrical Inspectors—Southern Section, George Washington Hotel, Jacksonville, Fla., October 27-29.

National Electrical Manufacturers Association—Annual Meeting Hotel Traymore, Atlantic City, October 27-31.

Southeastern Electric Exchange—Sales Conference, Biltmore Hotel, Atlanta, October 29-31.

Missouri Valley Electric Association—Rural Roundtable, Skirvin Hotel, Oklahoma City, Okla., October 30; Sales and Rural Conference, Skirvin Hotel Oklahoma City, Okla., October 31-November 1.

National Electronics Conference — Edgewater Beach Hotel, Chicago, November 3-5.

American Institute of Electrical Engineers—Midwest General Meeting, Congress Hotel, Chicago, November 3-7.

International Lighting Exposition and Conference—Stevens Hotel, Chicago, November 3-7.

Pennsylvania Electric Association — Communications Committee, Lord Baltimore Hotel, Baltimore, November 13-14.

SEC RULINGS

East Coast Public Service Co received, in an order supplementing SEC approval of the company's Section 11 (E) plan, commission endorsement of its proposal to distribute 90,000 common shares of the East Coast Electric Co, a subsidiary, to holders of its own common stock at the rate of three shares for each share held and then dissolve. The dissolution of East Coast Public Service was authorized on September 30 in Wilmington, Del., by Federal District Judge Paul Leahy as a result of the SEC's approval of the plan for dissolution. (Release No. 7748).

Repurlic Service Corp's proposal to sell to Pennsylvania Power & Light Co for a base price of $674,590 all the outstanding securities of Mauch Chunk Heat, Power & Electric Light Co, Renovo Edison Light, Heat & Power Co, and Renovo Heating Co has been approved. Pennsylvania Power will pay the purchase price in shares of its own common, together with certain cash adjustments to date of closing the transaction. (Release No. 7749).

St. Joseph Light & Power Co's proposal to acquire from its parent, the Continental Gas & Electric Corp, all 17,712 outstanding shares of the Maryville Electric Light & Power Co's outstanding $100 par value common stock in exchange for a like number of shares of St. Joseph's $100 par value common has been sanctioned. Immediately after acquiring the common shares of Maryville, which also is a subsidiary of Continental, St. Joseph intends to dissolve Maryville. In connection with these transactions, St. Joseph will amend its certificate of incorporation to increase its authorized common shares from 35,000 to 45,000 shares; will sell $990,000 of first mortgage bonds, 2¾ percent series, due 1976, at 101, to three insurance companies, and will borrow $300,000 from four banks at 2¼ percent. (Release No. 7757).

Electric Bond & Share Co's application for a six-month extension from October 6, 1947 to dispose of its common stock holdings of American Gas & Electric Co, Caroline Power & Light Co and Birmingham Electric Co, has been granted. In its application Electric Bond & Share stated a six months' extension was necessary to effectuate the sale of its remaining common holdings in three companies. (Release No. 7771).

Alabama Power Co's application for authority to issue and sell under competitive bidding conditions $10,000,000 principal amount of 30-year first-mortgage bonds has been approved. The company proposes to use the proceeds for construction of property additions, and to reimburse the treasury for expenditures already made for this purpose. (Release No. 7773).

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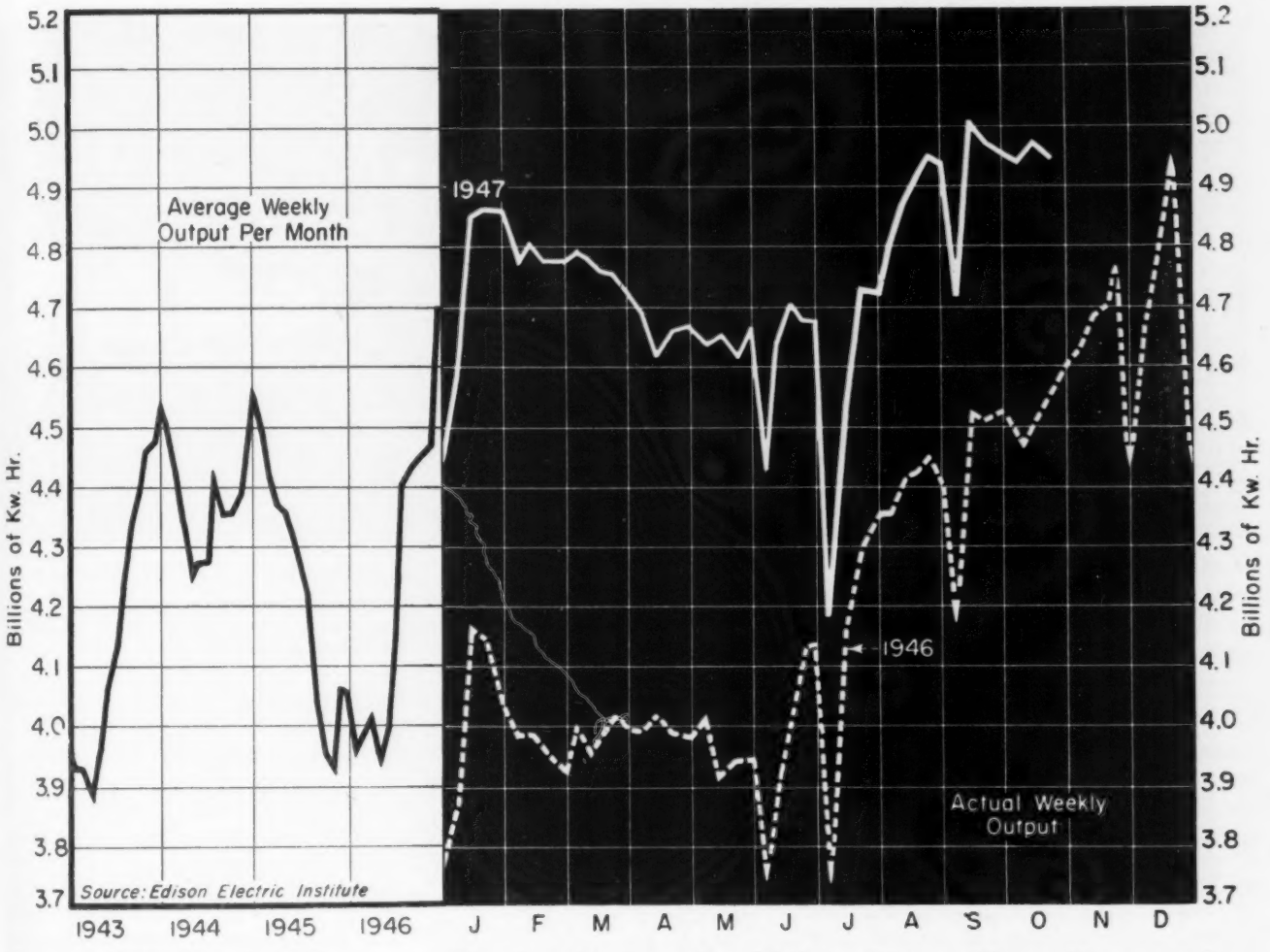
From 25 to 60 Cycles

New York State Electric & Gas Corp has begun to change its system in Lockport, N. Y., from 25 to 60 cycles. The changeover will take three years.



Oregon PUD Staves Off Injunction Asked by Utility

A long battle between public and private power interests in The Dalles, Ore., and surrounding areas ended in a legal decision favorable to peoples utility district advocates when Judge Walter L. Tooze of Portland, sitting in the Circuit Court of Wasco County, denied an injunction sought by the Pacific Power & Light Co and a number of taxpayers which would have restrained the Northern Wasco PUD from selling $225,000 in revenue bonds.

In his decision Judge Tooze said in effect that the wisdom or folly of a municipal corporation is an affair of the voters who elect the heads of the corporation. Unless these leaders act illegally, the court cannot interfere, he said.

Northern Wasco PUD was organized in 1939, and in 1940 the district approved a $475,000 bond issue to set up an electric system. Efforts to buy out the Pacific Power & Light Co in the area failed, and in December, 1946, the PUD adopted a resolution providing for the sale of $225,000 in revenue bonds for construction of the first unit of the proposed system. Before the bonds could be offered for sale the utility brought its suit, claiming changed conditions now make it impossible to build a complete system for the $475,000 authorized by voters.

•

Germany Lacks Water

So severe has been the drought in Germany that in the American Zone only 8 percent of the electricity consumed in recent months has been from hydro plants. A year ago the figure was about 60 percent. Despite severe rationing, coal that was stockpiled for use during the coming winter is being used. Some plants which should have a 30 days' supply are down to 7 days'. All are in a desperate plight.

26.3% More

Electric output of the Louisville Gas & Electric Co for the week ended September 13 was 35,603,000 kwhr, 26.3 percent more than for the corresponding week of 1946. The national increase was only 11.8 percent.

Output Moves Downward

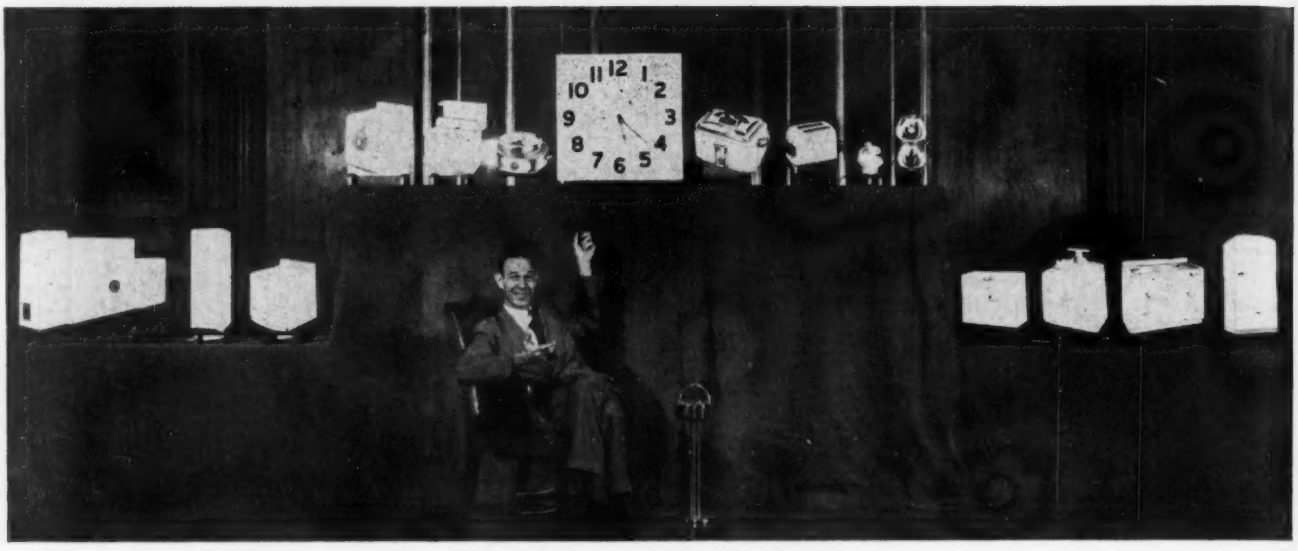
The electric output curve turned downward during the week ended October 18, 1947, according to figures released by the Edison Electric Institute. The amount of electrical energy distributed by the light and power companies totaled 4,946,090,000 kwhr, comparing with 4,958,062,000 kwhr during the preceding week. During the week ended October 19, 1946, the total amount of electrical energy distributed was 4,539,712,000 kwhr, this year's figure representing an increase of 9.0 percent, the smallest increase for any week this year.

Weekly Output, Millions Kwhr

1947		1946		1945	
Oct. 18	4,946	Oct. 19	4,540	Oct. 20	3,915
Oct. 11	4,958	Oct. 12	4,495	Oct. 13	3,934
Oct. 4	4,935	Oct. 5	4,478	Oct. 6	4,028
Sept. 27	4,956	Sept. 28	4,518	Sept. 29	4,039
Sept. 20	4,977	Sept. 21	4,507	Sept. 22	4,019
Sept. 13	5,053	Sept. 14	4,521	Sept. 15	4,106
Sept. 6	4,721	Sept. 7	4,184	Sept. 8	3,909
Aug. 30	4,940	Aug. 31	4,404	Sept. 1	4,137
Aug. 23	4,953	Aug. 24	4,444	Aug. 25	4,116
Aug. 16	4,923	Aug. 17	4,422	Aug. 18	3,939

Percent Change from Previous Year

	Oct. 18	Oct. 11	Oct. 4
New England	+ 6.1	+ 9.3	+ 7.7
Mid-Atlantic	+ 6.6	+ 6.3	+ 6.6
Central Industrial	+11.7	+13.6	+15.2
West Central	+ 9.2	+12.3	+ 9.7
Southern States	+10.1	+ 9.7	+ 7.8
Rocky Mountain	+ 9.6	+14.4	+16.7
Pacific Coast	+ 5.5	+ 8.4	+ 8.6
Total United States	+ 9.0	+10.3	+10.2



"ONLY 5:20, AND I FEEL FINE," says Will T. Clark, manager of residential sales at the Cleveland Electric Illuminating Co, at the end of his sketch, "Father Does the Housework." His audience of 650 consisted of the women in the households of the management group of the utility. Clark used the replicas of household appliances in his sketch where he played the part of a husband who stayed home to prove to his wife that her work was easy if she did it the electric way

Canadian Output in July Continues at High Level

Output of Canadian central electric stations continued at a high level during July. Consumption of primary power in Canada increased to the point that the total for the year to date is for the first time running higher than in record 1944.

July output was 3,750,881,000 kwhr, a record for July. However, this total was exceeded by four of the six previous months of 1947.

Consumption of primary power during the month was 3,064,219,000 kwhr. Only May's 3,159,460,000 kwhr exceeded this. For the first seven months primary consumption was 21,119,319,000 kwhr. This is slightly higher than the 20,922,546,000 kwhr of the corresponding period in 1944.

The following statistics are in thousands of kilowatthours:

Period	1947	1946
Seven months	26,614,411	24,109,055
Primary	21,954,911	18,472,952
Secondary	4,659,500	5,636,103
Exports to U.S.	1,287,700	1,550,869
July	3,750,881	3,422,826
Primary	3,189,569	2,621,903
Secondary	561,312	800,923
Exports to U.S.	217,171	251,522
June	3,755,862	3,415,306
Primary	3,134,620	2,621,976
Secondary	621,242	793,330
Exports to U.S.	192,227	229,685

•

Heating Rate Rise Halted

The Washington Department of Public Utilities has suspended the Puget Sound Power & Light Co's proposed increase in electrical rates for house heating (ELECTRICAL WORLD, October 4, page 5), pending a public hearing. The department is approving the company's application to reduce rates to small commercial users in the Seattle "competitive area."

•

Texas P&L Forming Firm to Provide Fuel Supplies

Texas Power & Light Co plans to form a new corporation under Texas Laws to acquire the oil, gas, and mineral rights (except coal and lignite) under the lands it owns in Texas. The proposed new corporation, according to an application filed with the Securities and Exchange Commission, would be tentatively called Gas & Oil Production Co. It would acquire and develop the oil and gas lands solely to provide a fuel supply for its parent.

The new company would be a wholly owned subsidiary of Texas Power and would issue five shares of its $100 par capital stock in return for the latter's oil and mineral rights. Texas Power is a subsidiary of American Power & Light Co.

The lands now owned by Texas Power were acquired for public utility purposes. It is its intention that land hereafter acquired by it will be for similar purposes.

Although the utility has no present intention of disposing of its oil and gas rights to any independent buyer, the existence of a corporation would facilitate negotiations for a sale "when and if Texas Power should desire to make such sale," the application added.

Portland Electric Power Reorganization Approved

With the recent confirmation by Judge James Alger Fee in United States District Court at Portland of reorganization plans for the Portland Electric Power Co, eight years of legal controversy virtually ended. All that remained was preparation of a formal order of confirmation.

Under the reorganization plans as finally approved (ELECTRICAL WORLD, August 16, page 59) provision is made for dissolution of Portland Electric Power Co and exchange of its securities for stock in the Portland General Electric Co, a subsidiary. The exchange involves distribution of $31,000,000 in stocks and bonds and payment of $9,000,000 in cash to various groups of security holders.

•

Sells Street Lights

Albany, Ore., will sell its ornamental street lighting system to the Mountain States Power Co for $2,000. The city has found it impracticable to maintain the lights.

Other News

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Electrical World
OPINION

Training for Relay Testers

MOST men who practice the highly specialized art of relaying on utility systems today have grown up with it, absorbing the technology of each new advance as it came along. Young men just entering the field, green, lack this advantage. They face the task of absorbing a vast amount of accumulated knowledge and skill.

Too little is being done to make their task easier. Recruiting of engineering graduates for relay work would be vastly more successful if candidates could look forward to a training program that would fit them, as they work, for progressive advancement.

The absence of such a program may explain the reluctance of college men to enter the relay field through the only door that stands open to them—apprenticeship as meter and relay testers. Beyond this door, they see only years of grubbing through the back alleys of routine maintenance and testing, while slowly they learn the intricacies of the relay art—largely on their own.

One opportunity for improving the situation lies in speedy completion of the new relay handbook. For this there is great need. Such an up-to-date reference could serve as the backbone for courses that would give testers and junior relay engineers fundamental, basic training. This training would help them advance through the grades to full professional stature.

Many companies now offer night school courses in differential equations, symmetrical components, even fishing and fly tying. These have their places, certainly. Yet too many fail utterly to give young men the fundamental training in relay technology they need so sorely.

But there is a further need. The young engineer should be shown that the relay field is unique. It offers opportunities for progress beyond relaying, through calculating board studies to system planning, and on to the broader responsibilities in the executive branch of engineering.

Training alone falls short of its goal if it fails to inspire. Horatio Alger's familiar formula for success still has its appeal for youth. But the road from relay tester to chief engineer today is a lot rougher than when the art was young.

Heat Pump Also Presents Rate and Supply Problems

AS A practical operating machine, the heat pump now exists. As a commercial proposition in respect simply to its own manufacture and sale, it is being born. As anything more than a mere novel application of electric service, it is still in the early stages of gestation.

Anyone who reads the recently published heat pump report of the EEI indoor climate committee must agree with those three conclusions. The machine works. Manufacturers have progressed far beyond just academic interest in it. But what a long, long way there is for the utilities to go to make it a commonplace user of electricity.

In the utility, the heat pump is of primary concern to three parties. They are the sales, rate, and distribution engineering departments, as is indicated in the report. Of the three, the sales department will have the easiest job. It will have for sale a thing in demand. The work of the rate department will be complicated and tedious, but that is usual and rate men revel in it. It is the distribution engineer who will have the tough assignment.

The report is a product of a committee of EEI's commercial division. Thus, it does little more than advert, in passing, to the tasks the heat pump will impose on the rate man and on the distribution engineer. This suggests that the industry would be well served if these two would study and report on the heat pump from their respective points of view. The industry should not only be prepared to promote the heat pump, but be prepared as well to supply adequately and to price equitably the electricity it will use.

Contacts and Connectors

IT is hard to conceive an electrical circuit wholly free of connections and contacts. Most circuits have many contacts of either permanent or intermittent type. Thus, it stands to reason that contacts must be good contacts in the sense that they offer low resistance. Otherwise they will incur losses and local heating. Risk of attendant damage to insulation, and of ignition of inflammable material, was one of the early urges to study electrical contacts.

Mathematically, the study is an intricate one. This is because the problem is essentially one of chance points, rather than areas of contact, unless intimacy is assured by welding, brazing or soldering. All mechanically made joints consist basically of a multiplicity of point contacts. Betterment of the contact is a matter of multiplying the number of points. Polishing, silvering, pressured foils are typical measures to multiply points of contact in switches and bolted connections.

The mechanical connector of other than the compression type belongs to this broad family of contacts. Whether a connector is good or bad depends on how big and per-

manent a family of contacts of its own it actually affords. Great confidence has been placed in the ingenious designs created to meet the demand. But murmurs have been heard increasingly that connectors have not wholly measured up to the fond expectations created when they appeared on the scene to obviate the cumbersome use of solder for line connections. They can, if properly applied, offer a healthily large number of contacts.

Candidly, the makers of mechanical connectors have something to worry about. Likewise, they have a superb excuse for research. The objective should be to achieve a much better approach to the conditions obtained when metal is merged with metal by fusion, pressure or a plastic intermedium.

Corrosion, cold flow, expansion-contraction, vibration are all factors to be explored more penetratively than ever before. Circuits are still to be loaded heavily during the coming peak season. It would be doubly bad if an epidemic of line failures should accompany measures taken to eke out generating capacity. That could expose consumers to two curtailments—and one could be avoidable. Connectors are often critically placed and merit critical analysis to render them capable of superior performance.

Few Accidents Are Accidents

MUCH MORE PROGRESS in reduction of accidents in the electric utility field could conceivably be made if the term accident could be discarded. Occasionally, a misadventure fails of explanation—the means of preventing a repetition are not discernible. But the great bulk of mishaps to employees consists of preventable happenings. They are preventable in the sense that if well-established (not necessarily well-recognized) precepts had been followed, the occurrence would have been prevented.

Significant at the moment is the tooling provided recently by the EEI Accident Prevention Committee. Exceptionally tangible and applicable means have recently been provided to educate staffs about the causes and avoidances of accidents. So many new implements have been shaped that there could be real meaning to the phrase "few accidents are accidents." So many techniques and warnings have been prepared that most of the "accidents" turn out to be hardly more than missteps that need not have been taken.

Electric utility work is a bit more hazardous (in terms of frequency of disabling injuries) than average American industry. It is 50 percent worse than the average industry in terms of the severity index. The industry could easily be *better* than average if the managements would seek and apply the teachings and toolings of the accident prevention group. There is no valid excuse for letting an unfortunate slip happen the second time. So much is now known about hazards and their avoidance that there is less and less excuse for letting accidents happen the first time.

WASHINGTON COMMENT

W. B. WHICHARD

RURAL Electrification Administration has turned in the first official alarm on the national "power shortage." It beat other federal agencies to the alarm box by hardly more than a step.

At any rate, REA contends that scarcity of generating capacity is cramping expansion of rural electric service in several specific areas. This was the major point of a recent speech by Administrator Wickard before Arkansas co-op members. He and other REA staff members may be expected to expand upon this theme.

Regardless of REA's motives, the electric utility industry might do well to sidestep debate on the nature of the shortage. There are better means of meeting the issue. But insistence by industry spokesmen that there is only a shortage of reserve capacity, rather than any "power shortage in the general sense of the term," is ineffectual. The average layman regards this as a quarrel over semantics.

He may be more impressed by the dossier which REA may have on the subject. Wickard indicated that his agency has collected a number of reports from co-ops and other borrowers on local cases of tight power supply. It would be naive to assume that REA has missed the numerous newspaper and other accounts of outages, voltage reductions and outright service curtailments resorted to by several companies. All this is likely to spell "shortage" to the general public, listening to an open debate in terms it does not comprehend.

But the revelation of these reports in documented form need cause no sensation. The American public apparently has been conditioned to shortages, even of utility service. For example, there has been little outcry against telephone companies because they have not been able to extend service as rapidly as they can sign up subscribers. The public knows that the war, labor strife and material shortages have delayed the manufacture and delivery of equipment.

The real danger in continuing to predict that there can be no "power shortage" lies in the very real possibility of failure of boilers, generators, or anything else. For any of a dozen systems, such failure could result in service interruptions, in one form or another. If lights go out in Philadelphia, St. Louis or San Francisco, for example, what will be the public reaction to repeated industry claims that "it can't happen here?"

The sooner the "shortage" story is told in plain layman's language, the better will be the industry's position. And the story should be told before every public power zealot in the country has had a fling at twisting it into a plausible indictment of the industry's integrity.

PLANNED LIGHTING Layout and Design Data

LIGHTING system design and layout practices are the core of planned lighting application. Between the appraisal of the seeing task and the achievement of an effective and economical lighting installation a number of critical selections and choices must be made.

Convenient data and accumulated experience together with a wide variety of available lamps, components and fixtures makes good lighting results relatively easy to achieve. Planned lighting, with its great potential benefits to industry, commerce and the home, is a practical technique available to all who have the training, experience and wisdom to apply it. As in other fields of engineering application, however, superior design and superior craftsmanship are essential to superior results.

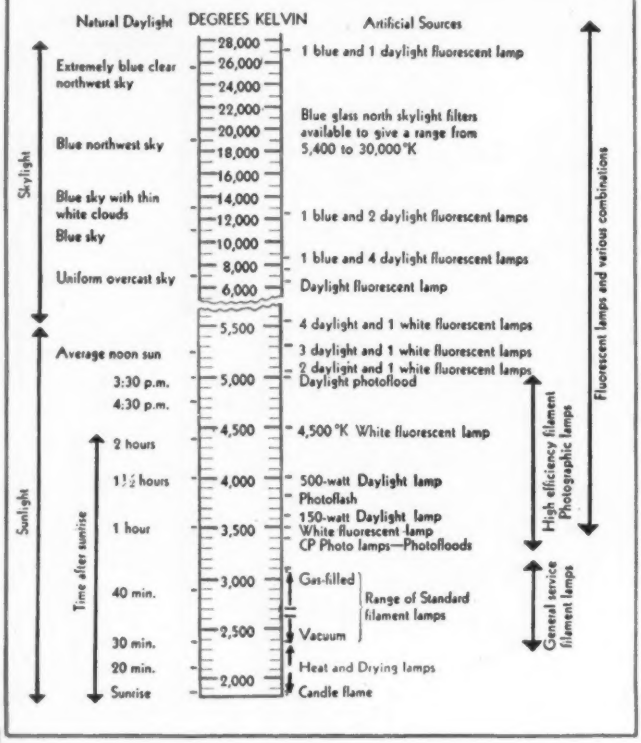
Planned lighting offers a tremendous scope for bold and imaginative applications of modern lighting equipment and techniques. The best practical interior illumination values are still far short of the daylight intensities and qualities under which our eyes evolved and the vital sense of sight developed. And most of the existing lighting under which we work and play is far below already recognized and practical illumination standards.

Lighting affects everyone directly in his daily affairs. Its progress cannot be appraised by the frontiers of scientific and engineering development alone. The countless applications of lighting, however small or large are a far more realistic measure. Each opportunity for improvement in one of them is a challenge to contribute to lighting progress as a whole.

The art of illumination and the lighting industry have a wealth of technical literature and experience from which lighting men can draw help and guidance. The essence is contained in many charts and tables which simplify the task of accurately predicting lighting values from the many variables which affect the lighting application. These data are the practical tools of applied lighting, and of practical lighting men.

In the following pages the editors have brought together a selection from the most essential and useful data for lighting system design and layout. A large proportion is derived from material prepared for the comprehensive new IES Handbook, and made available to us through the courtesy of the Illuminating Engineering Society and the Handbook editors.

COLOR QUALITY OF ILLUMINATION



LEVELS OF ILLUMINATION

	Footcandles
Starlight	0.0002
Moonlight	0.02
Street Lighting	0.6 — 1.2
Daylight	
At North Window	50-200
In Shade (Outdoors)	100-1000
Direct Sunlight	5000-10,000
RECOMMENDED ARTIFICIAL LIGHTING LEVELS	
Office Lighting	30-50
Store Lighting (General)	20-50
School Lighting (Class Rooms)	30-50
Drafting Rooms	50-100
MANUFACTURING PROCESSES	
Rough	20-30
Medium	30-50
Fine	50-100
Extra Fine	100-200

Source: Westinghouse Lighting Handbook

PLANNED LIGHTING

DESIRED

THE quality of a finished lighting installation is dependent upon several factors. The *quantity* of light, until recently considered a major consideration, is important. However, recent studies of comfort and ease of seeing put equal importance on *quality* of light, color harmony, low brightness ratios, and other similar factors.

Illumination levels for artificial lighting systems are guided by the type of occupancy in the area to be lighted, and the degree of criticalness of the seeing tasks involved. For general lighting, intensities up to 100 footcandles are currently recommended. Where seeing tasks are involved, values below ten footcandles should generally be avoided. Ten to 20 footcandles are considered adequate for rough work, such as the lighting of conference rooms, cafeterias, passageways, and of packing, loading and shipping departments. As the degree of criticalness of the seeing task increases, as in offices, stores, classrooms and drafting rooms, lighting intensities of from 20 to 100 footcandles are recommended. Tables at the top of this and the opposite page give recommended lighting intensities for a number of specific types of seeing tasks or area occupancies.

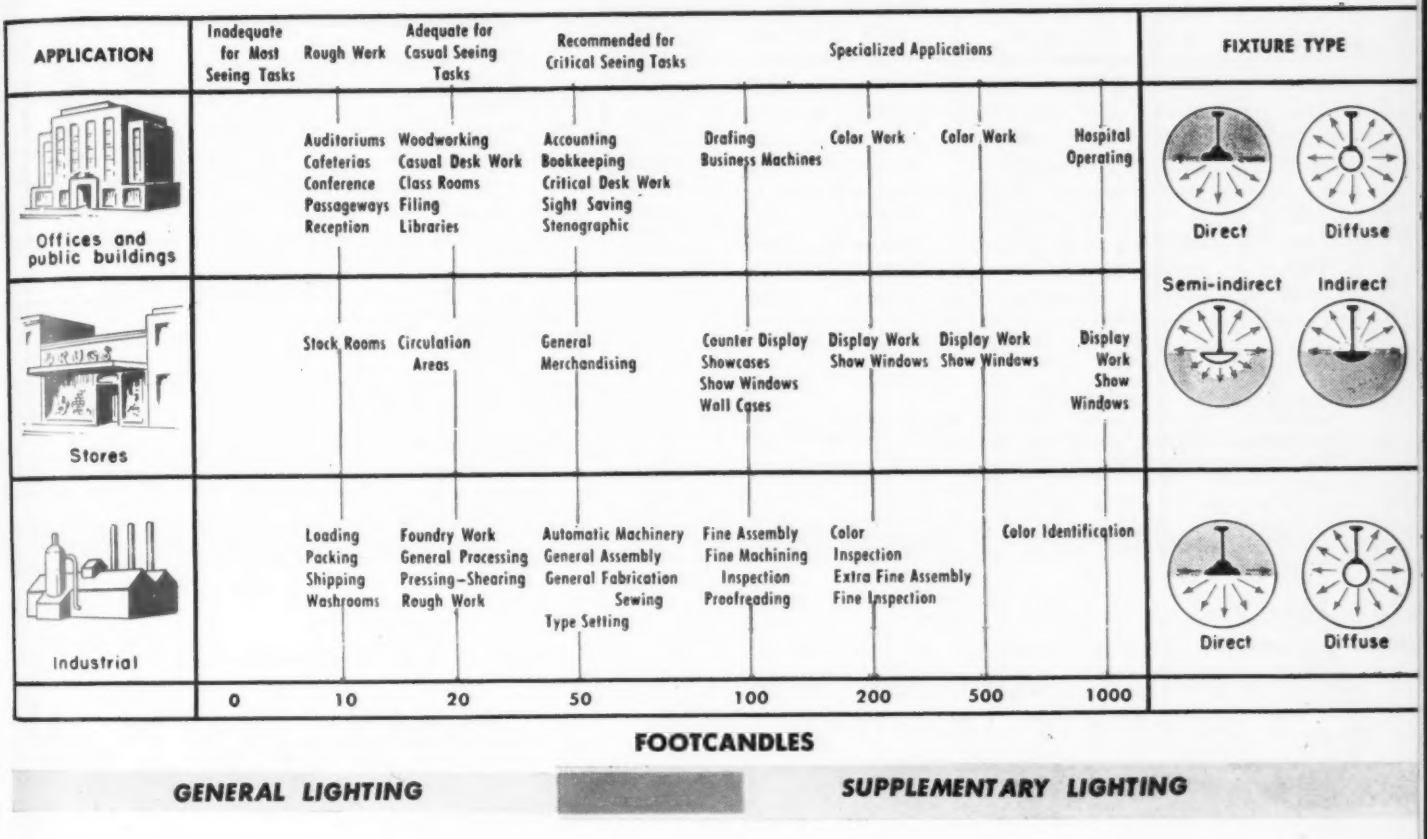
Supplementary lighting is normally used to provide lighting levels in excess of 100 footcandles. Such intensities are desirable in display lighting in stores and show windows, for sewing on dark materials, inspection, assembly of fine parts, color work and color identification.

The age of employees is an important consideration when selecting the lighting intensity for any specific work area. More light is required for equal ease in seeing for older persons, since eyes become less responsive with age.

Fluorescent lamps have opened up a new factor for consideration when planning a lighting system. These lamps are made in four degrees of whiteness for general lighting, as well as in a variety of colors for decorative and spectacular lighting effects. This makes it necessary to consider the *color quality* of the light best suited for each area or type of seeing task. It is now possible to choose artificial light sources, or combinations, which will produce practically any *color quality* desired for the final lighting result. Color quality of the resulting illumination is particularly important in the lighting of merchandise in stores, or in the manufacture of products involving color.

In general, incandescent or filament lamps produce a yellowish light, with low wattage lamps being more yellow and high wattage lamps increasing in whiteness as the wattage increases. Mercury vapor lamps appear bluish-white in color. Fluorescent lamps are made in soft white, 3500-degree white, 4500-degree white and daylight, or 6500-degree white. Thus, when a warm tone is desired in the final lighting result, low wattage incandescent lamps or soft white fluorescent lamps are appropriate. Noon sunlight quality of light can be produced by 4500-degree white fluorescent lamps, and north skylight quality by daylight

RECOMMENDED ARTIFICIAL ILLUMINATION LEVELS



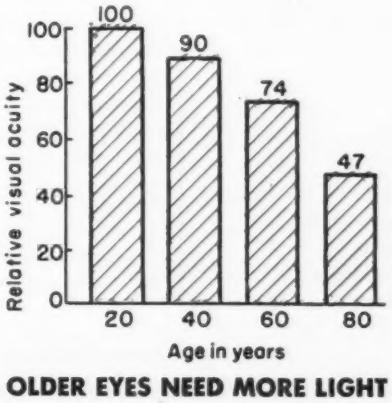
LIGHTING RESULTS

fluorescent lamps, or by high wattage incandescent lamps and daylight-blue glass filters. Other color qualities, as compared with natural daylight throughout the day, can be matched by combinations of the above light sources, or by combinations of these sources and colored lamps, such as blue, green, yellow, red and orange.

Ceiling and wall colors and finishes are also important factors in lighting, as are the colors and finishes of furniture, machines, draperies and other furnishings. The apparent color of any surface is affected by the color quality of the light falling upon it. Also, light reflected from any object is affected by the color of the object.

Many solutions are, of course, possible for any specific lighting problem. Quantity and quality of the final lighting result are of prime importance where ease of seeing is paramount. Many lighting problems involve decorative treatments and aesthetic considerations. Usually, it is possible to obtain decorative treatment with white light on colored surfaces, or with colored light on white or neutral surfaces, or with a combination of both. The lighting result required for a cinema auditorium, ball room or night club, for example, will involve aesthetic consideration and decorative treatment primarily. Problems of architectural and decorative treatment are subject to the individual taste of the lighting designer and the amount of money available to do the job. The fact that any specific lighting problem may be successfully solved in many ways is largely responsible for the unusual fascination of lighting design work.

Any well informed lighting engineer can easily plan a satisfactory lighting system to provide a specific lighting result. The major problem is to determine exactly what that lighting result should be, or to adequately define and describe this result—to the architect, decorator or customer. Footcandles can be measured with an instrument. So can brightness, to establish brightness ratios and contrasts. But many factors comprising a lighting result cannot be measured. They pertain to comfort in seeing, harmony in color treatment, architectural and decorative harmony and other considerations. They all contribute to the success of the final lighting result desired and must be thoroughly understood by the lighting engineer.



OLDER EYES NEED MORE LIGHT

Watts	Bulb	Initial Lumens	Initial L. P. W.	Rated Average Life (hrs.)
25	A-19	260	10.4	750
40	A-19	465	11.7	1,000
60	A-19	835	13.9	1,000
100	A-21	1,630	16.3	750
150	PS-25	2,600	17.2	750
200	PS-30	3,650	18.3	750
300	PS-35	5,900	19.7	750
500	PS-40	10,000	20.0	1,000
750	PS-52	14,550	19.4	1,000
1000	PS-52	21,500	21.5	1,000
1500	PS-52	33,000	22.0	1,000
2000	PS-52	44,000	22.0	1,000

Source: Sylvania Electric Products, Inc.

* Available for 120 volt operation. Some lamps also available for other voltages. For additional data and listing of other types of lamps, see lamp manufacturers' data bulletins, or IES Lighting Handbook.

STANDARD* INCANDESCENT LAMPS

Watts (Lamp Only)	Base (Bipin)	Nominal Length (Inches)	Bulb	Initial Lumen Output (100 Hrs.) Soft White	3500° White	4500° White	Daylight
(PREHEAT-STARTING)							
15	Medium	18	T-8	487	622	585	555
15	Medium	18	T-12	472	600	570	517
20	Medium	24	T-12	720	940	860	800
30	Medium	36	T-8	1720	1485	1380	1350
40	Medium	48	T-12	1760	2310	2110	1960
40	Mogul	60	T-17	....	....	2100	....
100	Mogul	60	T-17	3350	4300	4000	3900
(INSTANT START)							
40**	Medium	48	T-12	....	2320	2100	1920
40**	Mogul	60	T-17	....	....	2100	....

Source: IES Lighting Handbook

* Lamps listed are for general lighting purposes. Additional lamps for special application and for decorative lighting available. See lamp manufacturers' catalogs, or IES Lighting Handbook.

** Bipin base has pins short-circuited inside end caps. Lamps will not operate on preheat ballast circuits.

STANDARD* FLUORESCENT LAMPS

PLANNED LIGHTING

SELECTION of

LISTED on these two pages are standard light sources normally used for general lighting purposes. Many other lamps are available. Lamp manufacturers' catalogs should be consulted for other wattages, shapes, ratings, and listings of colored light sources.

Factors to be considered in selecting the light source for any specific application include color quality of the light produced, lamp life, lumen depreciation throughout life, efficiency of converting electrical energy into light, stroboscopic effect, and effect of ambient temperature surrounding the light source on its light output. When fluorescent lamps are indicated as being suitable for a specific lighting problem, it is also necessary to determine the type of cathode which is most suitable for the job.

Light sources normally used for general lighting include incandescent, mercury vapor and fluorescent. Incandescent lamps are point sources of light, and light distribution can be controlled fairly accurately. Rated life is low, averaging 1000 hours actual burning. Light output is not affected by changes in room temperature. Mercury vapor lamps have long life, averaging 3000 to 5000 hours, are approximately double the efficiency of incandescent lamps, have approximate point source for accurate light control, but are subject to decrease in efficiency in abnormal room temperatures.

Fluorescent lamps are line sources and are excellent for diffuse distribution. Slimline lamps afford fair light control because of their small diameter. Rated life is affected by frequency of starts, and varies from 2500 to 6500 hours.

COMPARATIVE STROBOSCOPIC EFFECT OF VARIOUS LAMPS
Operated on 60-Cycle Supply

Lamp and Method of Operation	Relative Stroboscopic Effect
200-Watt Incandescent	1
40-Watt Incandescent	7
Green Fluorescent—Single-Lamp Ballast	11
White Fluorescent—Single-Lamp Ballast	19
Blue Fluorescent—Single-Lamp Ballast	49
White Fluorescent—Two-Lamp Ballast	9
White Fluorescent—Three Lamps: Single-Lamp Ballasts on Separate Phases of a Three-Phase Circuit	3
White Fluorescent—Three Lamps, One on Single-Lamp Ballast, Remaining Pair on Two-Lamp Ballast	14

Source: IES Lighting Handbook

EFFICIENCIES OF VARIOUS LIGHT SOURCES
Approximate Lumens per Watt

Candle (Luminous Efficiency Equivalent)	0.1
Oil Lamp (Luminous Efficiency Equivalent)	0.3
Original Incandescent Lamp (1879)	1.4
60-Watt Carbon Filament Lamp (1905)	4.0
60-Watt Coiled Coil Tungsten Filament Lamp (1947)	13.9
1000-Watt General Service Lamp (1947)	21.5
No. 1 Photoflood Lamp (1947)	34.6
400-Watt A-H1 Mercury Vapor Lamp (Lamp Only) (1947)	40.0
40-Watt White Fluorescent Lamp (Lamp Only) (1947)	58.0
96" T-8 White Slimline Lamp (Lamp Only) (1947)	64.0

Source: Westinghouse Lighting Handbook

Nominal Length (Inches)	Bulb	Watts (Lamp Only)	Lumen Output		Footlamberts	
			3500° Wh.	4500° Wh.	3500° Wh.	4500° Wh.
300 MILLIAMPERES (LAMP CURRENT)**						
42	T-6	16	915	880	1680	1600
64	T-6	24	1410	1370	1670	1600
72	T-8	22	1405	1340	1050	1000
96	T-8	30	1920	1800	1065	1000
600 MILLIAMPERES (LAMP CURRENT)**						
42	T-6	25	1400	1320	2590	2450
64	T-6	39	2100	2150	2560	2450
72	T-8	38	2350	2250	1755	1650
96	T-8	52	3250	3050	1790	1650

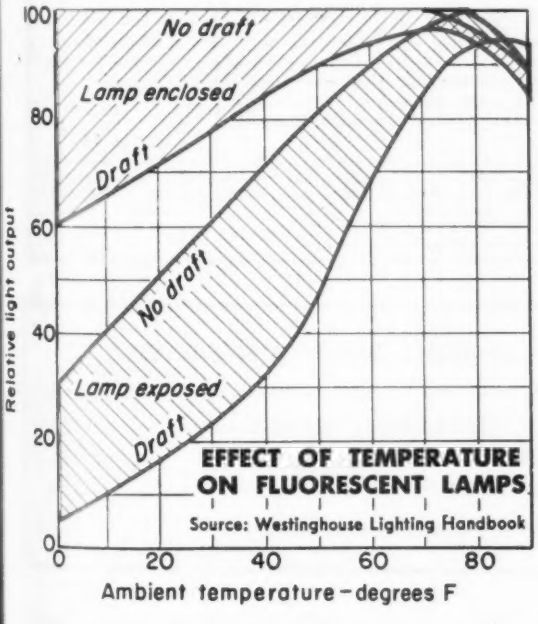
Source: IES Lighting Handbook, and G. E. Company, Bulletin LD-1
* Slimline lamps have a single pin base – for instant-start hot-cathode operation.
** Slimline lamps now available for 300 Milliamperes (Lamp Current) operation. Others not yet available.

STANDARD SLIMLINE* FLUORESCENT LAMPS

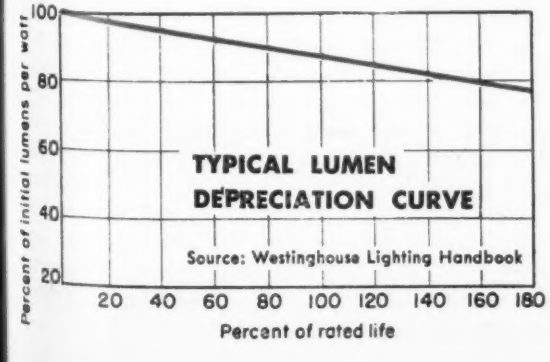
Lamp	Burning Hours per Start		
	3	6	12
6-W 9" T-5	2500	—	—
8-W 12" T-5	2500	—	—
13-W 21" T-5	2500	—	—
14-W 15" T-12	2500	—	—
15-W 18" T-8	2500	4000	6000
15-W 18" T-12	2500	4000	6000
20-W 24" T-12	2500	4000	6000
30-W 36" T-8	2500	4000	6000
40-W 48" T-12	2500	4000	6000
100-W 60" T-17	3000	4500	6500
Instant-Start			
40-W 48" T-12	2500	—	—
40-W 60" T-17	2500	—	—
Slimlines (All Types) Circline			
32-W 12" Diam. T-10	2500	—	—

RATED AVERAGE LIFE OF FLUORESCENT LAMPS IN HOURS

LIGHT SOURCES



EFFECT OF TEMPERATURE ON FLUORESCENT LAMPS
Source: Westinghouse Lighting Handbook



TYPICAL LUMEN DEPRECIATION CURVE
Source: Westinghouse Lighting Handbook

Tube Diameter (Outside)	Current	Volts Per Foot	Watts Per Foot	Initial Lumens Per Foot		
				3500° Wh.	Daylight	Warm Wh.
25	24	63	1.5	74	71	80
	48	57	2.7	142	132	150
	96	50	4.8	271	247	286
20	24	72	1.7	87	80	94
	48	64	3.1	172	159	184
	96	96	5.5	322	299	339
15	24	90	2.2	108	98	110
	48	81	3.9	190	172	203

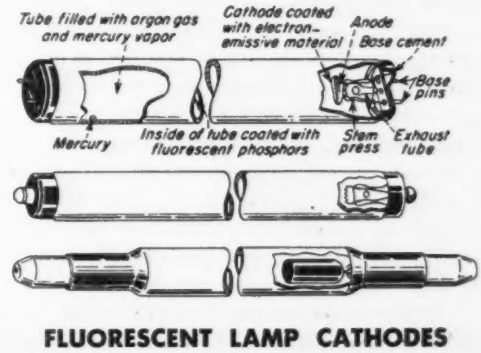
Source: IES Lighting Handbook
* Instant-starting lamps. Overall lengths, lumen output, life and voltages have been standardized by the Fluorescent Lighting Association.
Initial Lumens per foot for daylight lamps also apply to soft white lamps.

CYLINDRICAL (COLD) CATHODE* FLUORESCENT LAMPS

Watts (Lamp Only)	Type	Bulb	Lumens at 100 Hrs.	L.P.W. at 100 Hrs.	Rated Av. Life	
					5 hrs./st.	10 hrs./st.
100	H-4	T-10	3,000	30	1000	—
250	H-5	T-14	10,000	40	2000	3000
400	H-1	T-16	16,000	40	3000	5000
1000	H-12	T-28	60,000	60	2000	—
3000	H-9	T-9½	120,000	40	3000	—

Source: IES Lighting Handbook
* Lamps listed are for general lighting purposes.
Other mercury lamps also available for special application.

STANDARD* MERCURY LAMPS



FLUORESCENT LAMP CATHODES
Source: IES Lighting Handbook

PLANNED LIGHTING

SELECTION OF LIGHTING SYSTEM

TYPES OF LUMINAIRES

LIGHT DISTRIBUTION CLASSIFICATION	LUMINAIRE DESCRIPTION
DIRECT (A)	a. Suspended b. Ceiling mounted
SEMI-DIRECT (B)	c. Recessed d. Concealed (coffer and soffit)
GENERAL DIFFUSE (C)	e. Luminous elements f. Architectural elements
SEMI-INDIRECT (D)	g. Pedestal or floor mounted h. Wall mounted
INDIRECT (E)	i. Cove lighting j. Special ornamental

ILLUMINATION LEVELS FROM TYPICAL LUMINAIRES

LUMINAIRE TYPE	LAMP TYPE	FOOTCANDLES PER WATT PER SQUARE FOOT*
Suspended indirect	Incandescent	2 to 4
Shielded direct recessed	Incandescent	3 to 5
General diffuse	Incandescent	4 to 6
Open bottom direct	Incandescent	5 to 7
Suspended indirect	Fluorescent†	6 to 10
Shielded direct	Fluorescent†	8 to 12
Open bottom direct	Fluorescent†	10 to 14
Series and multiple thin fluorescent tubing and 40-watt, 60-inch (T-17) lamps in rooms with high-reflectance walls and ceilings		12 to 16

*Footcandles listed are those which may be expected after two years of average maintenance. The lower figures apply to small rooms finished in dark colors with poor maintenance.
†Any kind, preheat or cold cathode.
Source: IES Lighting Handbook

DESIRABLE REFLECTION FACTORS

CEILINGS	75-85%
WALLS	50-60%
DESK TOPS	25-35%
FLOORS	15-30%

Source: Westinghouse Lighting Handbook

THE type of lighting system which will meet the requirements for a specific lighting problem will be controlled to considerable extent by the lighting result which is desired. Ornamental and decorative considerations will also play a part, especially the color and finish of the interior.

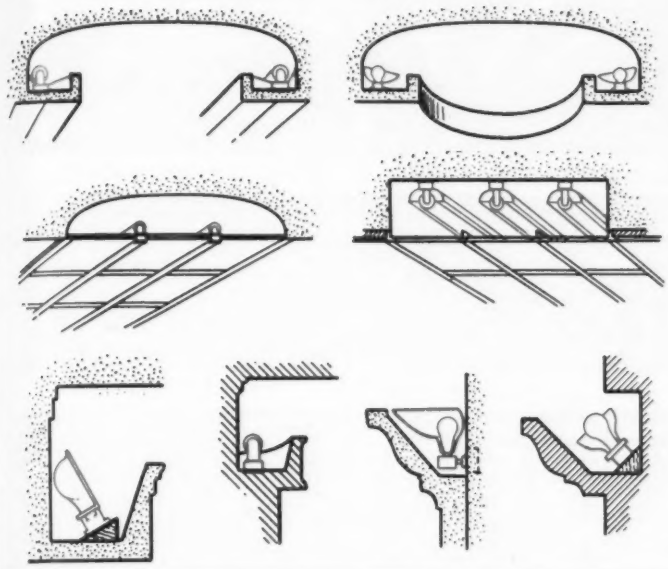
Lighting systems are classified according to type of light distribution, and to type of luminaires. Current techniques in solving lighting problems are generally to use more than one type of lighting system on each project. For example, general lighting in stores may be either of the five types of light distribution, from totally direct to totally indirect, and accent lighting may be superimposed on the general lighting system to provide highlights on feature displays. Current practice for lighting industrial areas is to use direct lighting from suspended, ceiling mounted or recessed luminaires for general lighting, and to provide supplementary lighting when required with supplementary type reflector units.

In any type of lighting system all light sources should be shielded from the normal field of view. Reflected glare should be avoided, especially in offices, classrooms and similar areas where specular reflection interferes with easy vision.

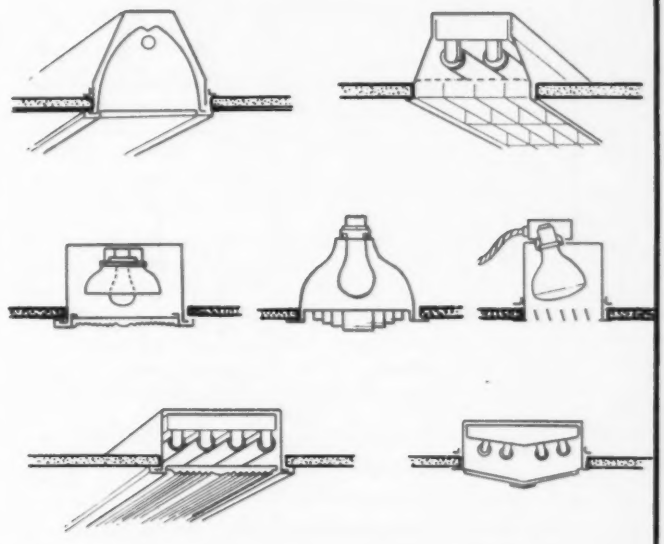
On the opposite page several types of luminaires and lighting equipment are shown. The list is not intended to be complete. However, it does indicate the wide range of types of luminaires and equipment which are available. For example, indirect lighting may be obtained with suspended luminaires, floor pedestals, wall urns, cove lighting or architectural elements. Direct lighting may be obtained with ceiling mounted or suspended luminaires, recessed units, concealed equipment or luminous and architectural elements.

In relighting installations, capacity of the existing wiring may limit both the footcandle intensities and the type of lighting system which may be used. Where reflection factors of ceiling, wall and floor finishes are low, the desired lighting result may be obtained by repainting in lighter colors having high luminous reflectance.

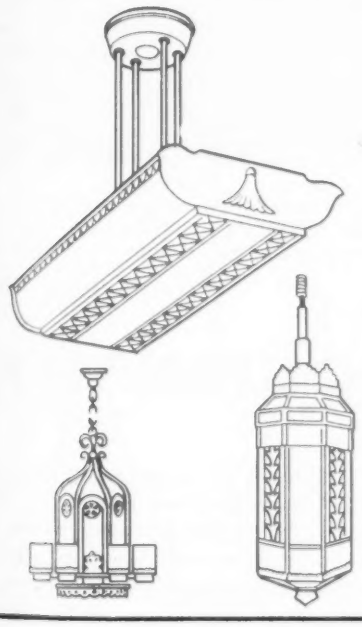
CONCEALED LIGHTING EQUIPMENT



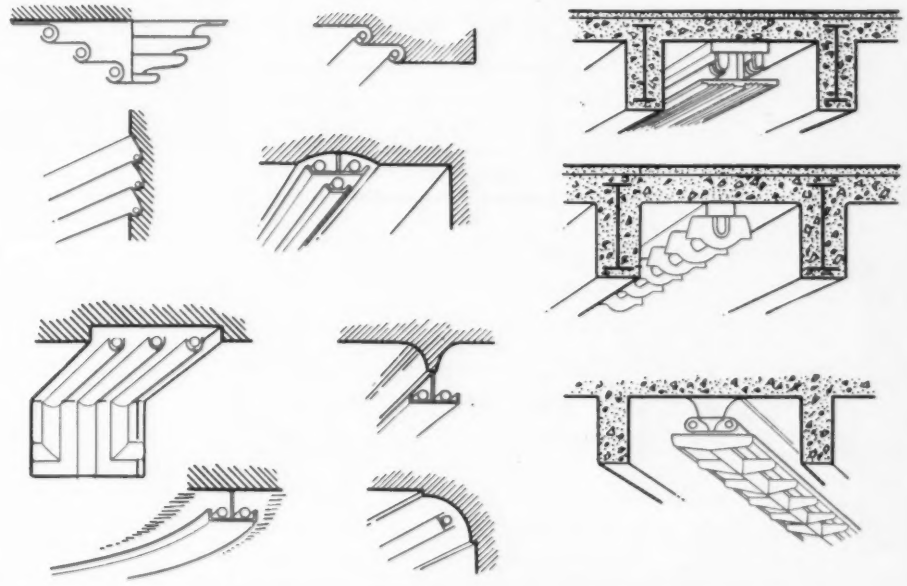
RECESSED LUMINAIRES



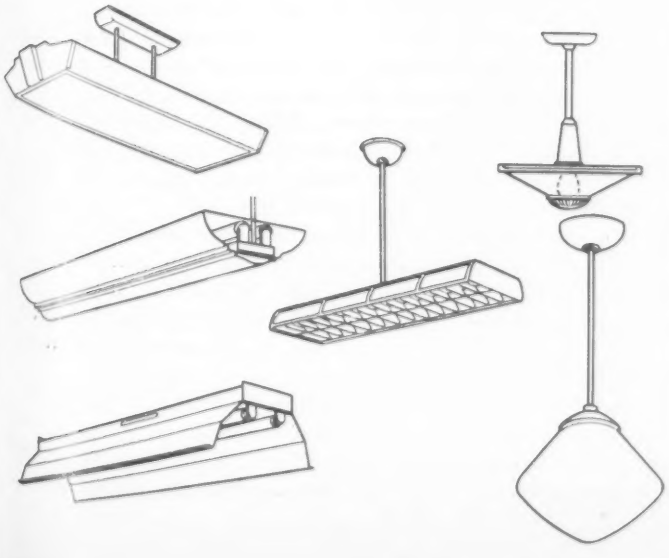
ORNAMENTAL LUMINAIRES



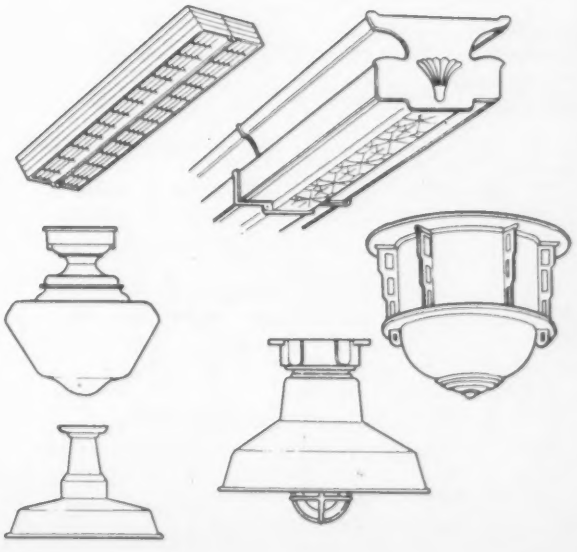
ARCHITECTURAL ELEMENTS

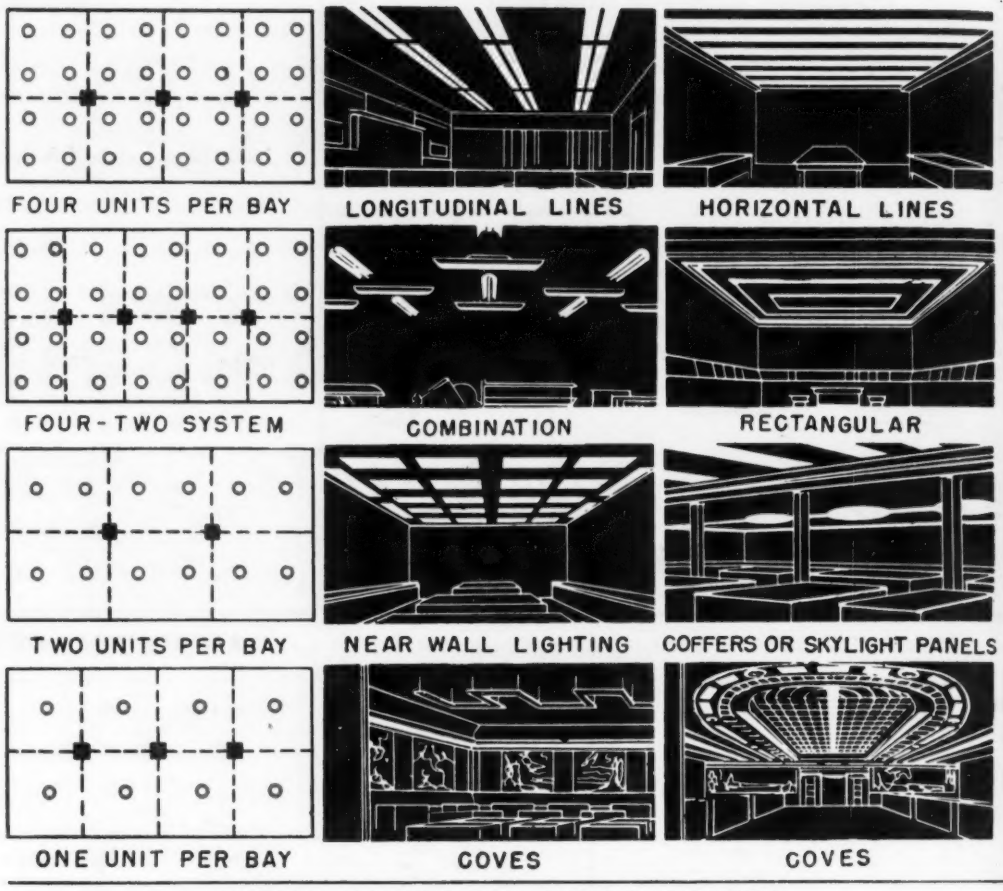


SUSPENDED LUMINAIRES



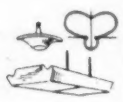
CEILING MOUNTED LUMINAIRES





TYPICAL LAYOUTS FOR GENERAL LIGHTING

LUMINAIRE SPACINGS

Light Distribution →	Indirect	Semi-Indirect	Semi-Direct	Direct
Mounting Height of Luminaire / Ceiling Height for Indirect and Semi-Indirect Luminaires				

All Dimensions in Feet	Maximum Spacing Between Units	Spacing* from Walls	Length of Suspension	The usual spacing is less than the maximum permissible to suit the room or bay arrangement.	Maximum Spacing Between Units	Spacing* from Walls
8	9	3	1-3		7½	3
9	10½	3	1½-3		9	3
10	12½	3½	2-3		10½	3½
11	13½	3½			12	3½
12	15	4	2½-4		13½	4
13	17	4	3-4		15	4
14	19	5			16½	5
15	20	5			18	5
16	22	6	4-5		20	6
18	24	6			22	6
20 or More	28	7	4-6		25	7

*These spacings apply where desks and benches are next to wall, otherwise one-half the spacing between units its satisfactory.

Source: General Electric Company

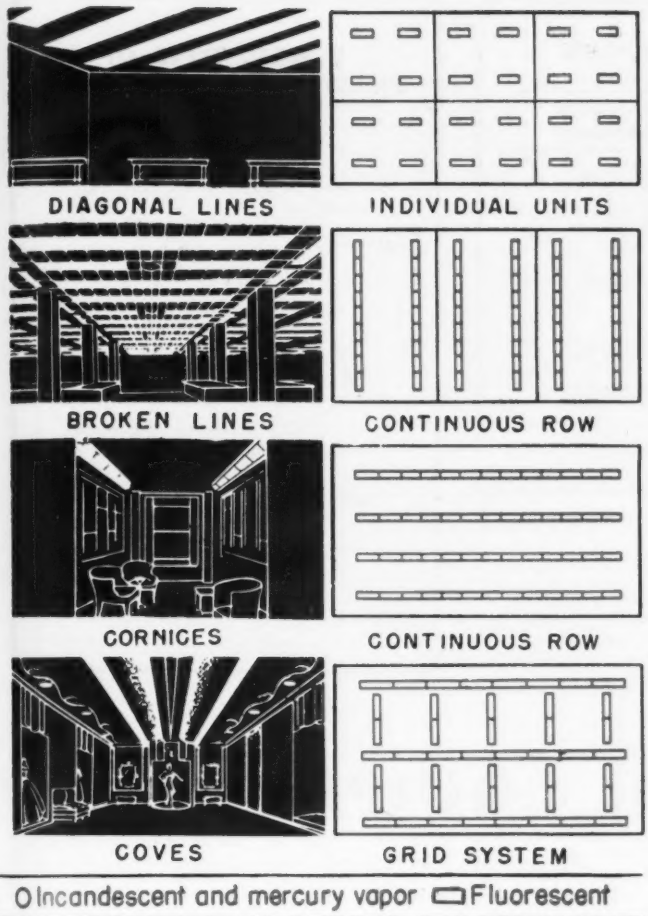
EQUIPMENT

AFTER the desired lighting result for a lighting problem has been determined, and the light source and lighting system has been selected, it is a relatively simple problem to locate the luminaires or reflector equipment. Fifteen simple rules are listed on the following page, under "Some Layout Reminders", to aid the lighting engineer in this task. Typical layouts used for general lighting are also shown in the illustrations at the top of these two pages.

Luminaire spacings are controlled by the light distribution of the luminaires, bay area dimensions, and mounting height of units. The table at the left may be used as a guide for spacing typical luminaires having light distribution patterns approximately as shown. When bay dimensions vary greatly from the spacings indicated for a specific type fixture, the units should be located closer and on spacings which will provide a symmetrical layout.

In general, when individual units are used, bay areas which are approximately square should be lighted with one unit located in the center of the bay, or with four units, each located in the center of each of the four quadrants of the bay. Spacing between units in adjacent bays should equal the spacing between units in the same bay. Such arrangements provide a degree of architectural or geometric harmony, and a more pleasing appearance.

When cove lighting is used to light an area, the cove should be located so that the distance from the ceiling to the



LAYOUT

cove is at least one-half the width of the ceiling being lighted by the cove. A ratio of three-fourths-to-one, or one-to-one, is preferred. The cove should be wide enough and deep enough to completely conceal the equipment below a sight line drawn across the top of the cove from a point six feet above the floor on the opposite wall line. Concentrating type reflectors with the center-line of the reflector axis pointing to the center of the ceiling or beyond the center is desirable in most cases, especially when the cove is located fairly close to the ceiling.

If coffers or soffits are used to light an area, the area of the lighted element should be from one-fourth to one-half the floor area, for intensities up to 20 footcandles. For higher intensities, up to 50 footcandles, it is desirable that the coffers or soffits cover practically all of the ceiling area. Otherwise, the lighted surfaces become sufficiently bright to cause glare. Louvered ceilings are now being used successfully for intensities of 50 footcandles and above, with direct lighting reflectors being mounted above the louvers and properly spaced to light the louvers uniformly. The louvers shield the light sources and present a low surface brightness when viewed normally from below. Louvered ceilings permit reflected glare, however, except when intensities are 50 footcandles or above, and except when low-brightness light sources are used. Reflected glare should be kept at a minimum on all types of installations.

SOME LAYOUT REMINDERS

The reason a customer buys a good lighting system is to get an adequate and comfortable lighting result—not just to buy lighting fixtures, lamps, conduit and wiring.

Lighting equipment selected should be appropriate for the interior and the visual tasks involved. Appearance, direct glare, reflected glare, shadows, maintenance, and light output efficiency are all factors in selecting the luminaires or lighting equipment.

The layout should fit the structural details of the building. If plans and drawings are not available, survey the interior and note location of columns, beams, obstructions and other architectural features.

Conventional layouts with symmetrical spacing of units are preferred, with units parallel and perpendicular to walls. Fancy geometrical patterns may be suitable in some cases, but should be avoided generally.

Many fluorescent luminaires are longer than the nominal length of the lamps they employ. When continuous row units are employed, fixture dimensions should be checked carefully.

Continuous row fluorescent units usually look better than individual units located with small spaces between adjacent ends. Economies in wiring and installation costs are usually effected with continuous row mounting, too.

Some manufacturers make the same standard model luminaire in different lengths. These details should be checked so that the most appropriate length units can be used in all locations.

Luminaires should be kept a foot or more away from walls, so that rooms will not look crowded with units.

There is a trend to recessed and ceiling-mounted installations. Check to see that use of such equipment will not produce uncomfortably dark ceilings and excessive brightness ratios in the field of view.

Suspended units which direct light both up and down often produce the best lighting result most economically. Check the suspension length carefully, and limit it to the value which gives reasonably uniform ceiling brightness.

Luminaire spacings should be used which produce uniform illumination and prevent bad shadows.

Layout should be planned to permit additional units to be added later. This will permit an increase in lighting intensity without spoiling the symmetry or architectural harmony of the initial installation.

Plan the maintenance program along with the lighting layout. Be sure that all units are easily accessible, and are designed to be cleaned easily and quickly.

Consider the finish and reflection factor of ceiling and side walls. Recommend proper colors and finishes to provide proper surrounding brightness conditions which promote eye comfort.

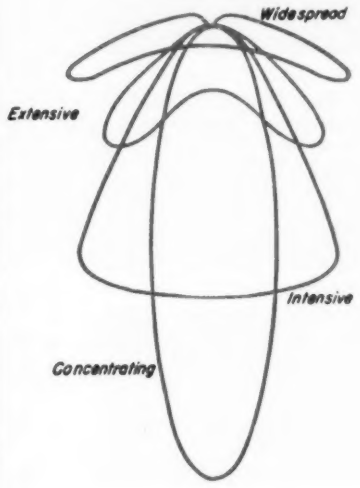
Double check all calculations and details, to insure the proper number of units and the final *lighting result* desired.

CLASSIFICATION OF LIGHT DISTRIBUTION

System	Upward Component	Downward Component
Indirect	90-100%	0-10%
Semi-Indirect	60-90%	10-40%
General Diffuse / Direct-Indirect	40-60%	40-60%
Semi-Direct	10-40%	60-90%
Direct	0-10%	90-100%

Source: IES Lighting Handbook

TYPICAL TYPES OF DIRECT LIGHT DISTRIBUTION



LIGHT CONTROL EQUIPMENT

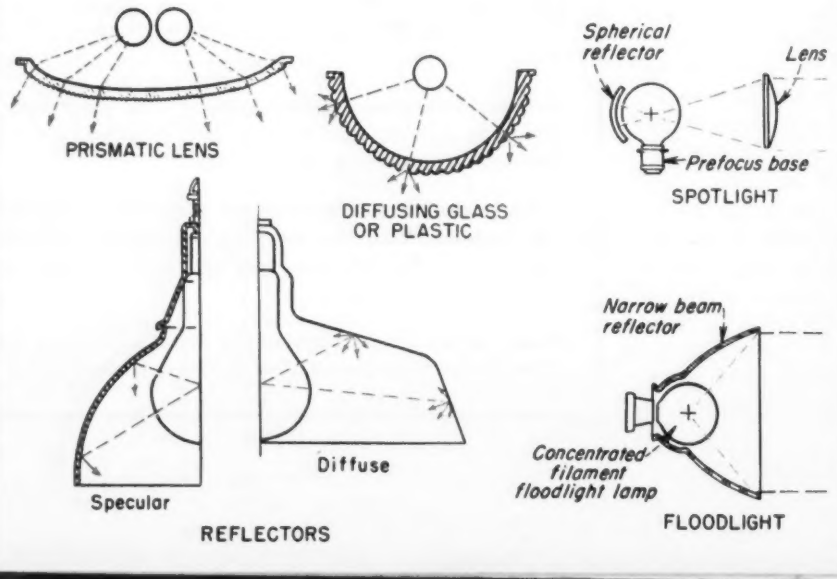
LIGHT control devices are selected by equipment manufacturers for their standard production models of luminaires and reflector equipment. However, it is the lighting engineer's responsibility to his customer to select light control devices which are best suited for each specific application. These devices may be incorporated in luminaires, or, in some instances, may be combined with architectural elements of the building, or in furniture, store fixtures and other interior furnishings. Reflectors installed in wall urns, floor pedestals, coves, and luminous or architectural elements are examples.

Nine examples of light reflection from various types of surfaces are shown in the illustration at the top of the next page. Application of these laws of reflection are shown in reflector equipment illustrated below. Light may also be controlled by refraction or diffusion through prismatic lenses or diffusing glass or plastics, and by shielding, as with louvers.

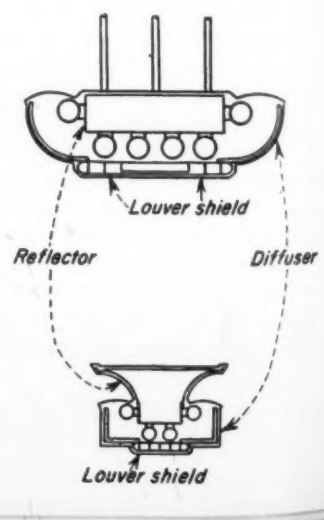
Light distribution from luminaires has been classified into five types by the International Commission on Illumination (I.C.I.). These five classifications are defined by the percentage of light directed upward or downward from the center of the luminaire. Percentage values for each classification are given in the Table above.

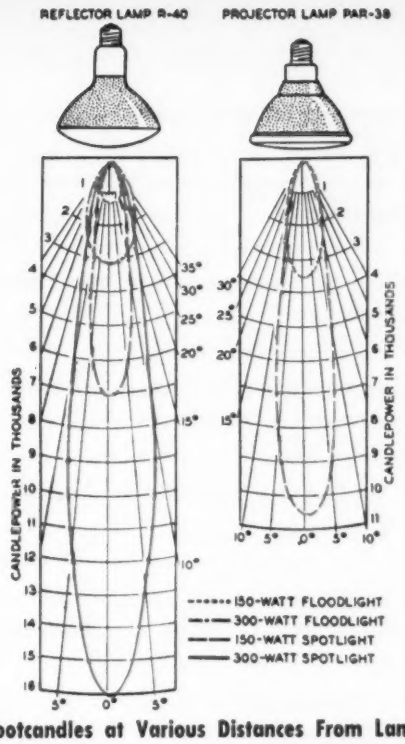
Important considerations in the selection of light control devices include efficiency, durability, ease of maintenance and attractive appearance. Reflectors with specular surfaces are used to obtain accurate light control. Concentrated and intensive light distribution require specular or semi-polished reflectors.

LIGHT CONTROL DEVICES



IN LUMINAIRES

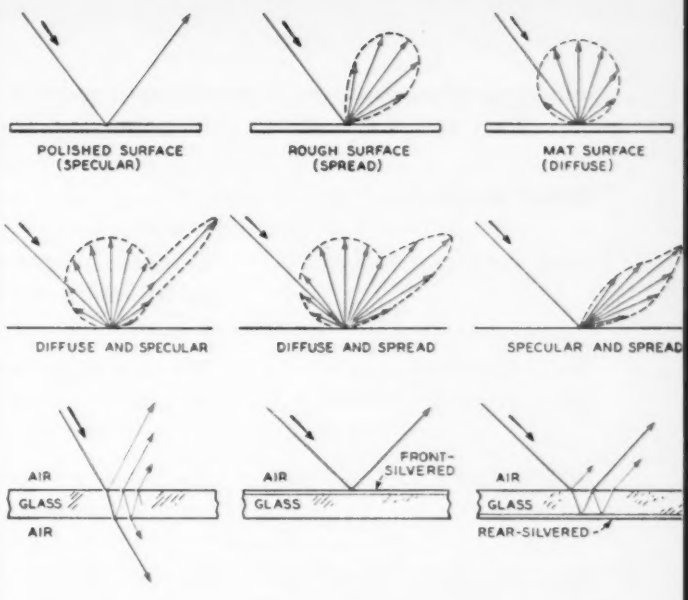




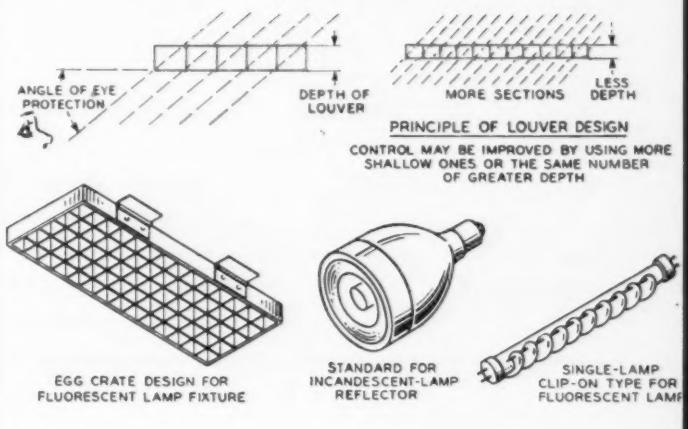
Footcandles at Various Distances From Lamps

	DISTANCE FROM LAMP							
	5 Feet		10 Feet		15 Feet		20 Feet	
	Size of Spot	F.C. at Center of Spot	Size of Spot	F.C. at Center of Spot	Size of Spot	F.C. at Center of Spot	Size of Spot	F.C. at Center of Spot
Projector Spot	3′	420	6′	105	9′	47	12′	26
Projector Flood	6′	100	12′	25	18′	11	24′	6
150-watt Reflector Spot	3′	280	6′	70	9′	31	12′	17
150-watt Reflector Flood	6′	48	12′	12	18′	5	24′	3
300-watt Reflector Spot	3′	640	6′	160	9′	71	12′	40
300-watt Reflector Flood	7′	120	14′	30	21′	13	28′	8

LAMPS WITH INTEGRAL REFLECTOR



TYPES OF REFLECTION FROM VARIOUS SURFACES


ANGLE OF EYE PROTECTION
DEPTH OF LOUVER
MORE SECTIONS
LESS DEPTH
PRINCIPLE OF LOUVER DESIGN
CONTROL MAY BE IMPROVED BY USING MORE SHALLOW ONES OR THE SAME NUMBER OF GREATER DEPTH
EGG CRATE DESIGN FOR FLUORESCENT LAMP FIXTURE
STANDARD FOR INCANDESCENT-LAMP REFLECTOR
SINGLE-LAMP CLIP-ON TYPE FOR FLUORESCENT LAMP

LOUVERS CONTROL LIGHT BY SHIELDING

Sources: IES Lighting Handbook

Medium spread light distribution is produced by semi-mat aluminum or silver-mirrored glass reflectors. Diffuse light distribution is produced by mat aluminum finished reflectors, silver-mirrored glass reflectors, porcelain enameled steel reflectors, or baked enamel reflecting surfaces. Mat surface ceilings, either painted with flat paint or unpainted plaster or acoustical material, produces a diffuse reflection.

A wide range of light distribution patterns, both symmetrical and asymmetrical, can be produced by silver-mirrored glass reflectors by change in contour of the reflectors. Such reflectors are particularly well adapted for use with incandescent and mercury vapor light sources where the light is confined to an approximate point source. These reflectors are less effective with fluorescent line sources where the source is one inch or more in diameter. The cost usually becomes prohibitive for the amount of control afforded.

Prismatic glass reflectors and refractors control the light distribution over a complete range from intensive to wide spread distribution through prismatic reflection or refraction. Such reflectors and refractors are highly durable and efficient. They are well-suited for incandescent and mercury vapor light sources, and have also been designed for use with fluorescent lamps.

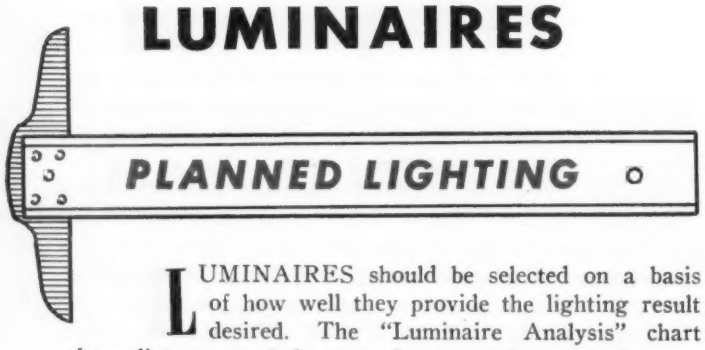
Diffuse aluminum, porcelain enameled steel and baked enamel finishes on steel or aluminum are excellent reflecting surfaces for fluorescent luminaires where diffuse or wide spread light distribution is desired. Specular aluminum reflectors in parabolic shape can be used with small diameter fluorescent lamps, such as slimline, cold cathode and T-8 lamps, to produce intensive distribution.

Several incandescent lamps are now available with integral reflector, such as the R-40 reflector spot and reflector flood, PAR-38 projector spot, and projector flood, and bowl-silvered lamps in a wide range of sizes and wattages. The R-40 and PAR-38 lamps are used primarily for display and accent lighting in stores, or where a concentrated beam of light is needed. Bowl-silvered lamps are used in suspension-type luminaires, containing a shielding bowl or rings, to provide indirect lighting for offices, reception rooms, stores, classrooms and similar areas.

LUMINAIRE ANALYSIS

Select Luminaire For	Comments
TYPE OF LIGHT SOURCE	Consider lumens per watt, size of lamps, color quality of the light produced by the lamp, lamp life and replacement cost.
TYPE OF LIGHT DISTRIBUTION	The type of lighting system and equipment layout selected will control the type of light distribution required for the luminaires or reflector equipment.
INITIAL LUMENS REQUIRED	The spacing of outlets and the desired lighting intensity will establish the light output in lumens required for each luminaire.
HIGH OVERALL EFFICIENCY	Overall efficiency of luminaires varies from a high of approximately 90 per cent downward. Fixture manufacturers' light output and distribution curve data should be consulted for luminaires selected.
HIGH QUALITY MATERIALS AND COMPONENTS	Reflectors should have permanent type reflecting surface. Diffusing media should be of high quality and present evenly lighted surface. Gauge of metals should be proper for necessary rigidity. Proper ventilation is important.
EASE OF MAINTENANCE	Luminaires should be easy to clean and relamp.
GOOD APPEARANCE	Luminaires should present a good appearance and harmonize with the interior or architecture where used. Plain, simple lines are usually preferred.
LOW COST	High first cost of equipment may prevent the installation of a good lighting system. Luminaires should be reasonably priced.

SELECTION OF LUMINAIRES



LUMINAIRES should be selected on a basis of how well they provide the lighting result desired. The "Luminaire Analysis" chart above lists some of the more important factors to be considered. There are, of course, other factors which should also be taken into account, depending on the type of luminaires involved and the type of area to be lighted.

Luminaires used for general lighting purposes should provide a high overall efficiency. They should also be designed to provide the necessary comfort in vision. That is, the light sources should be shielded to prevent direct glare in the normal field of vision. They should also prevent or minimize reflected glare, especially those selected to light offices, classrooms and drafting rooms.

Depending on the type of area to be lighted, it is often necessary to first select the type of luminaire which is to be used, and then plan the equipment layout around the light distribution of the luminaires selected. This procedure has the advantage of making it possible to use a particular type of luminaire and to adapt the layout to meet the necessary conditions imposed by the size and light distribution characteristics of the luminaire. When the appearance of the physical layout of luminaires is of greater importance, the equipment layout should be made first, and luminaires then selected to meet these requirements.

How luminaires will affect the appearance of the lighted room is an important factor. Highly ornate luminaires are less in favor today. The trend is toward plain, simple lines in exposed or recessed equipment. Many customers prefer recessed troffers or individual incandescent units, which have the effect of making the area appear larger.

Reflector materials and finishes are important. The materials should be such that the reflecting surface is permanent and will not deteriorate excessively from heat and repeated cleanings. Finishes should be proper for producing the type of light distribution required.

The electrical characteristics of auxiliaries used in fluorescent luminaires are also important. Ballasts should be of high power factor type, and ballasts, starter switches, lampholders and other electrical devices should be built to conform to underwriters' specifications.

ANALYSIS OF LIGHTING PROBLEM

PLANNED LIGHTING layouts are based on making a complete analysis of the lighting problems involved on each project, and then making a plan on which all lighting data are shown.

Factors involved in making an analysis of the lighting problem include the study of the seeing tasks which will obtain, the analysis of the desired lighting result, and the consideration of all physical properties of the area to be lighted. Physical considerations include area dimensions, ceiling heights, reflection factors of ceilings, walls, floors and furnishings, the degree of light interference by machines, furniture, workers, etc., and the wiring capacity required or existing. Physical considerations also include structural elements and architectural detail, especially where recessed or concealed equipment is involved.

Planning the lighting for new construction offers greater freedom in the choice of the lighting system, luminaires or equipment, wiring layout and control than does planning the relighting of an existing structure. The lighting designer should work closely with the architect and decorator in either case. In new construction the architect will be able to coordinate structural details with lighting details, thus providing better appearance in the final lighting result, and greater satisfaction for all concerned.

On relighting projects one of the first considerations is the capacity of the existing wiring system. Where the wiring system is inadequate, the lighting designer should provide a solution for the revamping of the wiring on an economical basis which will insure adequate capacity for the lighting system which he recommends. He should also carefully survey all existing srtuctural details and be sure the lighting system he recommends is feasible and practical, and that the luminaires and equipment can be installed in the locations indicated.

The ratio of the light produced by the lamps to the amount of light which ultimately reaches the working plane is a measure of efficiency of the lighting system. This is commonly referred to as the "Coefficient of Utilization". Tables on the following pages show coefficients of utilization for several types of luminaires under varying conditions of room sizes and reflection factors for ceilings and side walls. These data make it possible to predetermine fairly accurately the footcandle intensities which may be expected under a specific set of conditions. In making an analysis of the lighting problem, one of the objects is to summarize and list all information required to make these preliminary lighting calculations.

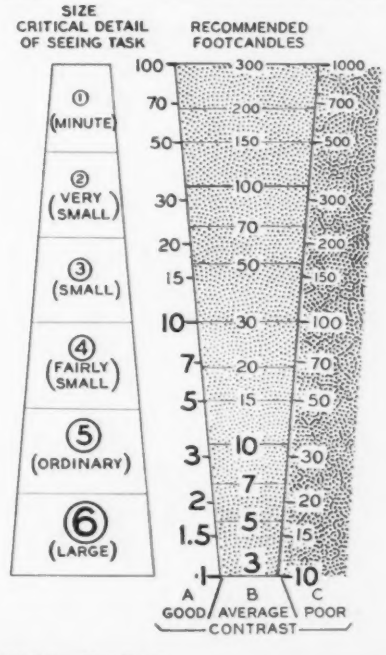
While it is important to recommend specific levels of illumination (usually the minimum found practical for specific types of work through experience and tests, or higher) and to provide the necessary number of luminaires of correct type to provide these levels, there are also other factors which it is important to consider. One such factor is the matter of brightness and brightness contrast. The brightness of luminaires, or of lighted elements including the ceiling when an indirect lighting system is used, should be kept at a minimum. These areas of brightness should be surrounded by areas whose brightness contrast is not great, as such conditions constitute glare. Care should be taken when luminaires or equipment are recessed flush in the ceiling, so that the contrast between the ceiling and the recessed units is within comfort limits. On recessed installations the ceilings should be finished white or in a very light color having a high reflection factor. Light walls, floors and furniture are also desirable on recessed installations, as these will usually reflect enough light back to the ceiling to prevent undue contrast. The influence of contrast on recommended intensities is shown below.

DIFFUSE REFLECTION FACTORS

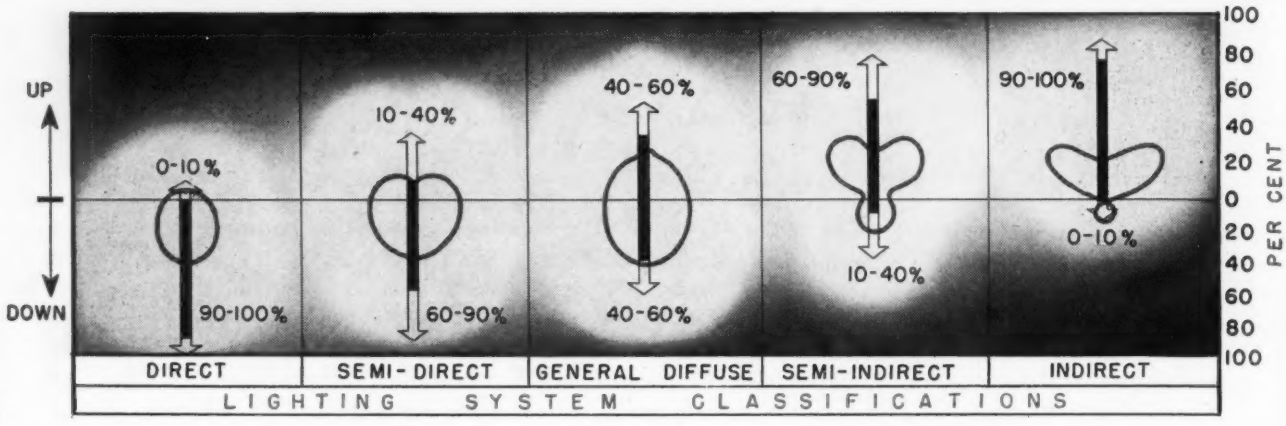
Color	Average Reflection Factor	Color	Average Reflection Factor
White	.88	**MEDIUM**	
		Blue-green	.54
		Yellow	.65
		Buff	.63
VERY LIGHT		Grey	.61
Blue-green	.76		
Cream	.81	**DARK**	
Blue	.65	Blue	.08
Buff	.76	Yellow	.50
Grey	.83	Brown	.10
		Grey	.25
		Green	.07
		Black	.03
LIGHT			
Blue-green	.72	**WOOD**	
Cream	.79	**FINISHES**	
Blue	.55	Maple	.42
Buff	.70	Walnut	.16
Grey	.73	Mahogany	.12

Source: Westinghouse "Data for Designing Interior Illumination" Bulletin

INFLUENCE OF SIZE AND CONTRAST


SIZE CRITICAL DETAIL OF SEEING TASK
RECOMMENDED FOOTCANDLES
① (MINUTE)
② (VERY SMALL)
③ (SMALL)
④ (FAIRLY SMALL)
⑤ (ORDINARY)
⑥ (LARGE)
100 70 50 30 20 15 10 7 5 3 2 1.5 1
300 200 150 100 70 50 30 20 15 10 7 5 3
1000 700 500 300 200 150 100 70 50 30 20 15 10
A GOOD
B AVERAGE
C POOR
CONTRAST

Source: IES Lighting Handbook



PLANNED LIGHTING

LIGHTING CALCULATIONS

FORMULAS FOR GENERAL LIGHTING DESIGN

$$\text{Average lumens reaching work plane} = \text{total initial lamp lumens} \times CU \times MF$$

$$\text{Average footcandles} = \frac{\text{total initial lamp lumens} \times CU \times MF}{\text{Area of room (sq. ft.)}}$$

$$= \frac{\text{initial lumens per lamp} \times CU \times MF}{\text{Area per lamp (sq. ft.)}}$$

$$= \frac{\text{initial lamp lumens per luminaire} \times CU \times MF}{\text{Area per luminaire (sq. ft.)}}$$

$$= \text{total watts per sq. ft.} \times \text{overall lumens per watt} \times CU \times MF$$

$$\text{Area per lamp (sq. ft.)} = \frac{\text{initial lumens per lamp} \times CU \times MF}{\text{Footcandle level desired}}$$

$$\text{Area per luminaire (sq. ft.)} = \frac{\text{initial lumens per lamp} \times \text{no. of lamps per luminaire} \times CU \times MF}{\text{Footcandle level desired}}$$

$$\text{Total Watts per sq. ft.} = \frac{\text{Footcandle level desired}}{\text{overall lumens per watt} \times CU \times MF}$$

CU = Coefficient of Utilization

MF = Maintenance Factor

THERE are two methods for calculating the quantity of light for an area, the *Lumen* method and the *Point-by-Point* method. The *Lumen* method is used here, as it is relatively simple and has been generally adopted for calculating general lighting intensities. It is accurate to the extent that each factor in the formulas, given at the left, is evaluated.

Average "in service" footcandles of general illumination can be estimated for a room, by inserting proper values in the formula at left. The procedure is as follows:

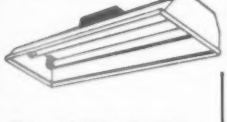
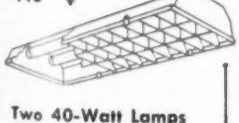
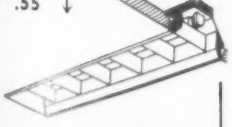
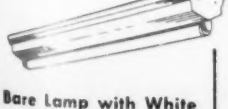
1. Determine the "total initial lamp lumens" by multiplying the number of lamp lumens per lamp by the number of lamps (See Tables under "Selection of Light Sources").
2. Determine area of room in square feet and room index from "Room Index Table".
3. Determine the coefficient of utilization (CU in the formula) for the type of luminaire recommended, using the "Coefficient of Utilization for Typical Luminaires" Table (See the next two pages).
4. Determine the maintenance factor (MF in the formula) for the type of fixture recommended, using the "Coefficient of Utilization for Typical Luminaires" Table, and based on whether maintenance will be "good", "medium" or "poor".
5. Apply these values in the second formula at the left. The result will be the calculated "average footcandles" which may be expected after the luminaires have been installed and in use long enough for dust, lamp life and dirt to depreciate the light output to the value estimated.

Coefficients of utilization vary for different luminaires having different light distribution characteristics. Typical types of luminaires have been selected for use in the "Coefficient of Utilization" Tables. Similar data should be obtained direct from fixture manufacturers for other luminaires having different light distribution or efficiency characteristics.

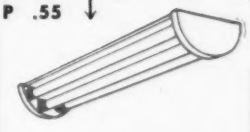
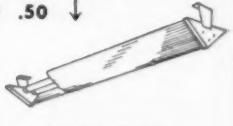
Analysis of the Room Index Table will show that large areas use light more efficiently than do small areas, because the ratio of wall area to floor area is less in larger rooms.

COEFFICIENTS OF UTILIZATION FOR TYPICAL LUMINAIRES

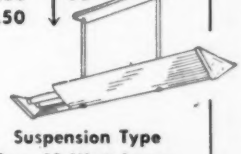
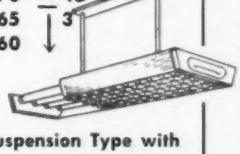
DIRECT LIGHTING

LUMINAIRE	Spacing not to exceed	Ceiling...	75%		50%	
		Walls....	50%	30%	50%	30%
		Room Index	COEFFICIENT OF UTILIZATION			
MF G .75 M .65 P .55 — 1 x MH — 0 / 79 R.L.M. Dome Reflector	1 x MH	J	.37	.31	.36	.31
		I	.45	.41	.45	.40
		H	.49	.45	.49	.45
		G	.53	.49	.53	.49
		F	.56	.53	.55	.52
		E	.61	.58	.60	.57
		D	.66	.63	.64	.62
		C	.67	.65	.66	.64
		B	.71	.68	.69	.67
		A	.72	.70	.71	.68
MF G .75 M .60 P .50 — 1 x MH — 0 / 75 Aluminum High-Bay Reflector, Medium Spread	1 x MH	J	.40	.36	.39	.36
		I	.48	.45	.47	.44
		H	.52	.50	.51	.49
		G	.55	.53	.55	.52
		F	.58	.56	.56	.55
		E	.62	.60	.61	.59
		D	.66	.63	.64	.62
		C	.67	.65	.66	.64
		B	.69	.67	.67	.65
		A	.70	.68	.69	.67
MF G .70 M .60 P .50 — 0.8 x MH — 0 / 53 Enclosed-Lens-Plate Distributing Type	0.8 x MH	J	.25	.22	.24	.22
		I	.31	.28	.29	.28
		H	.34	.31	.32	.31
		G	.36	.33	.34	.33
		F	.38	.35	.36	.34
		E	.40	.39	.39	.37
		D	.43	.41	.42	.40
		C	.45	.43	.44	.41
		B	.48	.45	.47	.43
		A	.50	.47	.48	.46
MF G .65 M .55 P. .45 — 1 x MH — 0 / 79  Two 40-Watt Lamps	1 x MH	J	.38	.32	.37	.32
		I	.47	.42	.46	.41
		H	.51	.47	.50	.47
		G	.55	.51	.54	.51
		F	.58	.54	.57	.53
		E	.63	.60	.62	.59
		D	.68	.64	.66	.64
		C	.70	.67	.68	.65
		B	.73	.70	.71	.68
		A	.74	.72	.72	.70
MF G .65 M. 55 P .45 — 0.9 x MH — 0 / 64  Two 40-Watt Lamps With Louvers,	0.9 x MH	J	.33	.28	.32	.28
		I	.39	.36	.39	.35
		H	.43	.40	.42	.40
		G	.46	.43	.45	.43
		F	.48	.46	.47	.45
		E	.52	.50	.51	.49
		D	.55	.53	.54	.52
		C	.57	.55	.56	.53
		B	.59	.57	.57	.56
		A	.60	.58	.59	.57
MF G .70 M .60 P .55 — 0.8 x MH — 0 / 65  Troffer with Louvers	0.8 x MH	J	.32	.28	.32	.28
		I	.40	.36	.39	.35
		H	.43	.39	.42	.39
		G	.46	.43	.45	.43
		F	.48	.45	.47	.45
		E	.52	.50	.51	.49
		D	.56	.54	.55	.53
		C	.57	.55	.56	.54
		B	.60	.58	.59	.57
		A	.61	.59	.60	.58
MF G .75 M .65 P .55 — 1 x MH — 8 / 77  Bare Lamp with White Reflecting Surface	1 x MH	J	.32	.27	.32	.26
		I	.40	.35	.39	.34
		H	.44	.39	.43	.39
		G	.48	.43	.46	.42
		F	.52	.47	.50	.46
		E	.57	.52	.55	.51
		D	.62	.56	.59	.55
		C	.65	.59	.62	.57
		B	.69	.63	.65	.61
		A	.71	.66	.67	.63

SEMI-DIRECT LIGHTING

LUMINAIRE	Spacing not to exceed	Ceiling...	75%		50%	
		Walls....	50%	30%	50%	30%
		Room Index	COEFFICIENT OF UTILIZATION			
MF G .75 M .65 P .55 — 1 x MH — 25 / 60  Exposed Lamps	1 x MH	J	.27	.25	.26	.22
		I	.35	.29	.33	.28
		H	.38	.34	.36	.32
		G	.43	.38	.40	.36
		F	.46	.41	.43	.39
		E	.50	.46	.47	.43
		D	.55	.50	.51	.47
		C	.58	.53	.53	.49
		B	.62	.57	.57	.53
		A	.64	.60	.59	.55
MF G .70 M .60 P .50 — 1.2 x MH — 18 / 49  Ceiling Type Two 40-Watt Lamps	1.2 x MH	J	.24	.20	.23	.19
		I	.30	.26	.28	.24
		H	.33	.29	.31	.28
		G	.36	.32	.34	.31
		F	.39	.35	.36	.33
		E	.42	.39	.40	.37
		D	.46	.43	.43	.40
		C	.48	.45	.44	.42
		B	.51	.48	.47	.45
		A	.52	.50	.49	.46
MF G .70 M .65 P .60 — 0.9 x MH — 15 / 45 Four 40-Watt Lamps With Louvers, Ceiling Type	0.9 x MH	J	.24	.21	.21	.19
		I	.30	.27	.26	.24
		H	.32	.30	.29	.27
		G	.35	.33	.31	.29
		F	.38	.35	.32	.31
		E	.40	.38	.35	.35
		D	.43	.40	.38	.36
		C	.45	.42	.39	.37
		B	.47	.45	.41	.39
		A	.48	.46	.42	.40

GENERAL DIFFUSE LIGHTING

LUMINAIRE	Spacing not to exceed	Ceiling...	75%		50%	
		Walls....	50%	30%	50%	30%
		Room Index	COEFFICIENT OF UTILIZATION			
MF G .75 M .70 P .65 — 1.2 x MH — 39 / 45 Totally Enclosed	1.2 x MH	J	.24	.19	.22	.18
		I	.29	.25	.27	.23
		H	.33	.28	.30	.26
		G	.37	.32	.33	.29
		F	.40	.36	.36	.32
		E	.45	.40	.40	.36
		D	.48	.43	.43	.39
		C	.51	.46	.45	.41
		B	.55	.50	.49	.45
		A	.57	.53	.51	.47
MF G .70 M .60 P .50 — 1.2 x MH — 47 / 36  Suspension Type Two 40-Watt Lamps	1.2 x MH	J	.26	.21	.22	.19
		I	.31	.26	.27	.24
		H	.34	.30	.30	.27
		G	.38	.34	.34	.30
		F	.41	.37	.36	.33
		E	.45	.41	.40	.36
		D	.49	.45	.42	.41
		C	.51	.48	.44	.44
		B	.55	.51	.47	.45
		A	.57	.53	.49	.46
MF G .70 M .65 P .60 — 1.2 x MH — 45 / 3  Suspension Type with Louvers Four 40-Watt Lamps	1.2 x MH	J	.26	.23	.23	.21
		I	.31	.28	.28	.26
		H	.35	.32	.31	.28
		G	.38	.35	.34	.31
		F	.41	.38	.36	.34
		E	.44	.42	.39	.37
		D	.48	.45	.42	.39
		C	.50	.49	.43	.41
		B	.53	.50	.46	.43
		A	.54	.52	.47	.45

MF = Maintenance Factor
G = Good
M = Medium
P = Poor
MH = Mounting Height

Source: IES Lighting Handbook

COEFFICIENTS OF UTILIZATION FOR TYPICAL LUMINAIRES

SEMI-INDIRECT LIGHTING

LUMINAIRE	Spacing not to exceed	Ceiling...	75%		50%	
		Walls....	50%	30%	50%	30%
		Room Index	COEFFICIENT OF UTILIZATION			
MF G .70 M .65 P .60 — 66 / 20 — 1.2 x CH		J	.20	.16	.16	.13
		I	.24	.20	.20	.17
		H	.28	.24	.23	.19
		G	.31	.27	.26	.22
		F	.34	.30	.28	.24
		E	.38	.34	.31	.27
		D	.42	.38	.34	.30
		C	.45	.41	.36	.32
		B	.49	.45	.39	.36
Totally Enclosed		A	.51	.47	.41	.38
MF G .60 M .50 P .40 — 70 / 11 — 1.2 x CH		J	.18	.14	.14	.11
		I	.22	.19	.17	.15
		H	.26	.22	.20	.17
		G	.29	.25	.22	.19
		F	.32	.28	.24	.21
		E	.35	.32	.27	.24
		D	.39	.35	.29	.26
		C	.42	.38	.31	.28
		B	.46	.42	.34	.31
Two 40-Watt Lamps		A	.48	.44	.36	.33

INDIRECT LIGHTING

LUMINAIRE	Spacing not to exceed	Ceiling...	75%		50%	
		Walls....	50%	30%	50%	30%
		Room Index	COEFFICIENT OF UTILIZATION			
MF G .65 M .55 P .45 — 85 / 0 — 1.2 x CH		J	.17	.14	.13	.11
		I	.21	.17	.16	.14
		H	.24	.21	.18	.15
		G	.27	.24	.21	.18
		F	.30	.27	.23	.20
		E	.33	.30	.25	.22
		D	.37	.33	.27	.25
		C	.39	.36	.29	.26
		B	.43	.40	.31	.30
Silvered Bowl		A	.45	.42	.34	.31
MF G .70 M. .60 P .50 — 79 / 3 — 1.2 x CH		J	.16	.13	.12	.10
		I	.20	.16	.15	.13
		H	.23	.20	.17	.14
		G	.26	.23	.20	.17
		F	.29	.26	.22	.19
		E	.32	.29	.24	.21
		D	.36	.32	.26	.24
		C	.38	.35	.28	.25
		B	.42	.39	.30	.29
Glass		A	.44	.41	.33	.30
MF G .60 M .50 P .40 — 80 / 0 — 1.2 x CH		J	.15	.11	.09	.08
		I	.19	.15	.12	.10
		H	.22	.19	.14	.12
		G	.26	.22	.17	.14
		F	.28	.24	.19	.16
		E	.32	.28	.21	.18
		D	.35	.31	.23	.21
		C	.38	.34	.25	.22
		B	.42	.39	.27	.25
Two 40-Watt Lamps		A	.43	.41	.29	.27

ROOM INDEX TABLE

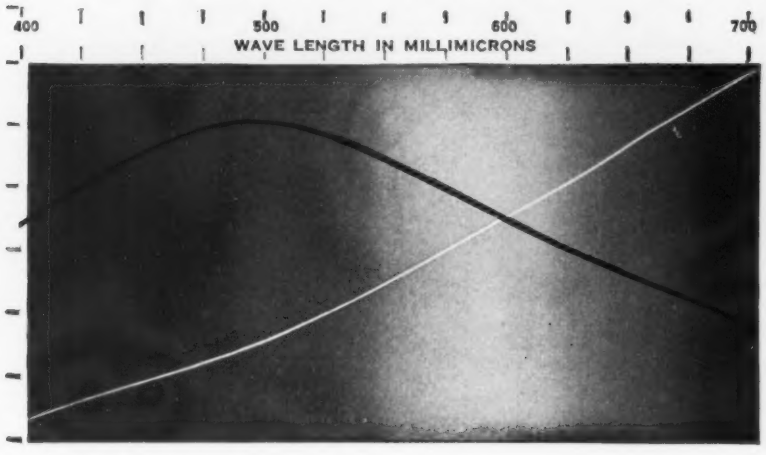
CEILING HEIGHT (FEET)							
Semi-indirect and Indirect Luminaires	9 to 9½	10 to 11½	12 to 13½	14 to 16½	17 to 20	21 to 24	25 to 30
MOUNTING HEIGHT ABOVE FLOOR (FEET)							
Direct, Semi-direct, General Diffuse, Direct-indirect Luminaires	7 to 7½	8 to 8½	9 to 9½	10 to 11½	12 to 13½	14 to 16½	17 to 20

ROOM WIDTH* (Feet)	ROOM LENGTH* (Feet)	ROOM INDEX						
10 (9½-10½)	10-14	G	H	I	J	J		
	14-20	G	H	I	J	J	J	
	20-30	F	G	H	I	J	J	
	30-42	F	G	G	H	I	J	J
	42-60	E	F	G	H	I	J	J
12 (11-12½)	11-14	G	H	I	I	J	J	
	14-20	F	G	H	I	J	J	
	20-30	F	G	G	H	I	J	J
	30-42	E	F	G	H	I	J	J
	42-60	E	F	F	G	H	I	J
14 (13-15½)	13-20	F	G	H	H	I	J	J
	20-30	E	F	G	H	I	J	J
	30-42	E	F	F	G	H	I	J
	42-60	E	E	F	F	H	I	J
17 (16-18½)	16-20	E	F	G	H	I	J	J
	20-30	E	F	F	G	H	I	J
	30-42	D	E	F	G	H	H	J
	42-60	D	E	E	F	G	G	I
20 (19-21½)	20-30	D	E	F	G	H	I	J
	30-42	D	E	E	F	G	H	I
	42-60	D	D	E	E	F	G	I
	60-90	C	D	E	E	F	G	H
	90-140	C	D	D	E	F	F	H
24 (22-26)	22-30	D	E	E	F	G	H	I
	30-42	C	D	E	F	G	G	I
	42-60	C	D	D	E	F	G	H
	60-90	C	D	D	E	F	F	H
	90-140	C	C	D	E	E	F	G
30 (27-33)	27-42	C	D	D	E	F	G	H
	42-60	C	C	D	D	F	F	H
	60-90	B	C	C	D	E	F	G
	90-140	B	C	C	D	E	E	F
36 (34-39)	34-42	B	C	D	E	F	F	H
	42-60	B	C	C	D	E	F	G
	60-90	A	C	C	C	E	E	F
	90-140	A	B	C	C	D	E	F
42 (40-45)	40-60	A	B	C	C	E	F	G
	60-90	A	B	B	C	D	E	F
	90-140	A	B	B	C	D	E	E
	140-200	A	A	B	C	D	D	E
50 (46-55)	46-60	A	A	B	C	D	E	F
	60-90	A	A	B	C	C	D	F
	90-140	A	A	A	C	C	D	E
	140-200	A	A	A	C	C	D	E
60 (56-67)	56-90	A	A	A	B	C	D	E
	90-140	A	A	A	B	C	C	D
	140-200	A	A	A	B	C	C	D
75 (68-90)	68-90	A	A	A	A	B	C	D
	90-140	A	A	A	A	B	C	D
	140-200	A	A	A	A	B	B	C

*For areas with dimensions greater than those shown in the table, use the following procedure to determine the room index:

1. Divide length and width by some common number which reduces dimensions to values within limits of table.
2. Subtract 2½ ft from the mounting height (or ceiling height) and divide this dimension by same divisor used in step 1.
3. Add 2½ ft to reduced height dimension and select the room index from the above table according to these new dimensions.

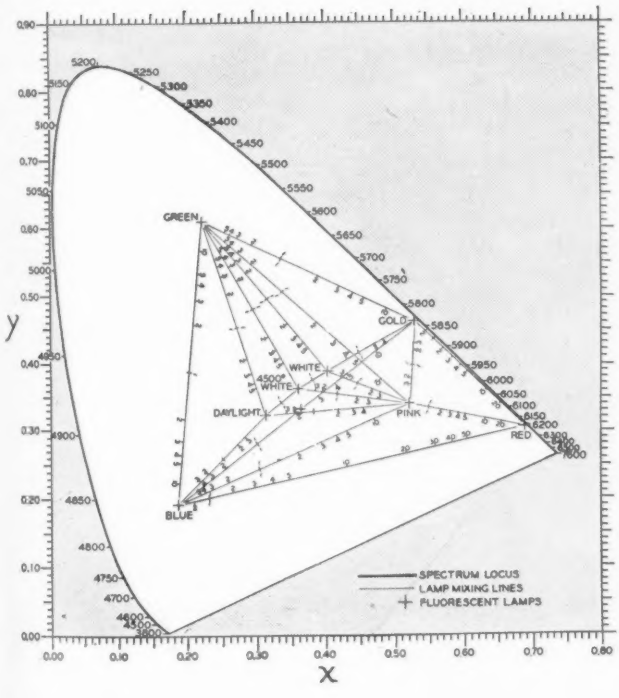
CORRECT PAINT COLOR COMPLEMENTS LIGHT



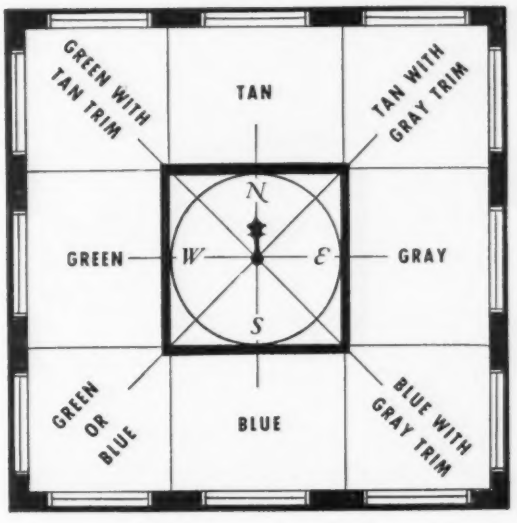
SOURCE: The Arco Company

COLOR IN LIGHTING

PLANNED LIGHTING



FLUORESCENT LAMP NOMOGRAM

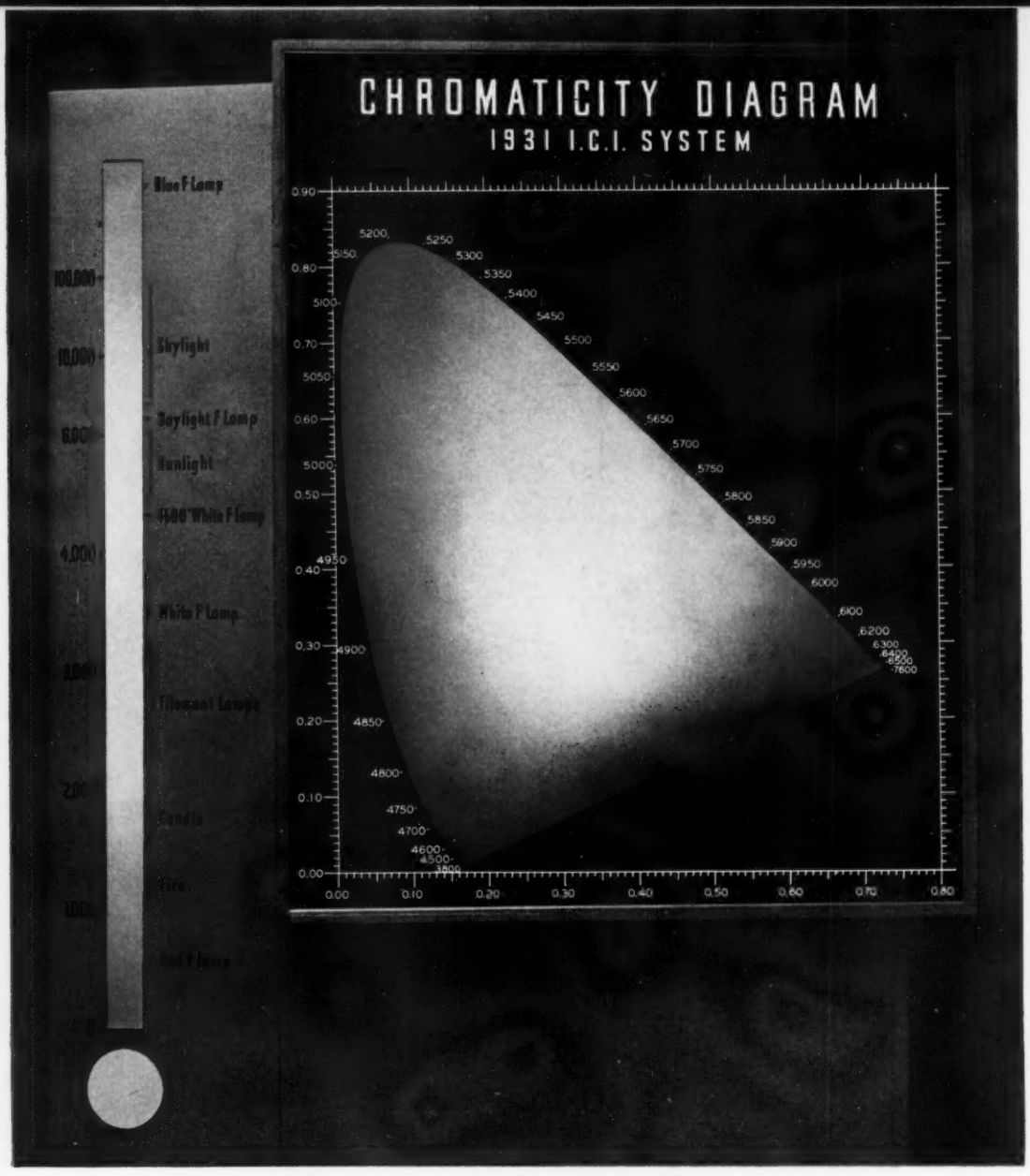


COLOR SELECTIONS FOR DAYLIGHTING

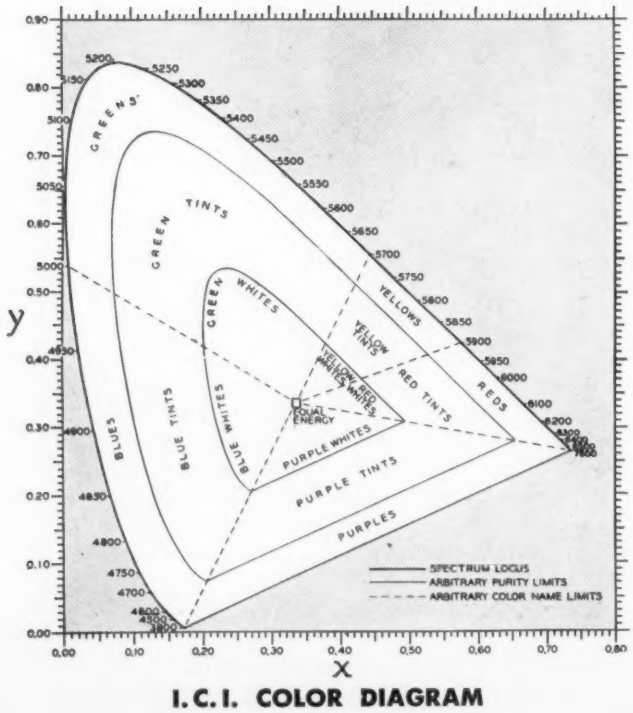
COLOR is an important subject for the illuminating engineer. Radiant energy which constitutes the visible spectrum is composed of pure spectral colors, or so-called color regions. In their simplest form, these color regions are divided into nine parts: violet, blue, blue-green, green, yellow-green, yellow, orange, light red and dark red. The visible spectrum is reproduced in color at the top of this page.

Light is produced by the radiant energy of wavelengths ranging from 380 to 760 millimicrons. Eyes perceive color sensation depending on how the radiant energy is distributed over these various wavelengths. Normal eyes are more sensitive to colors of relative equal energy in the green to yellow region of the visible spectrum, with the result that the eye-sensitivity curve peaks at this point from zero relative energy value at each end of the spectrum.

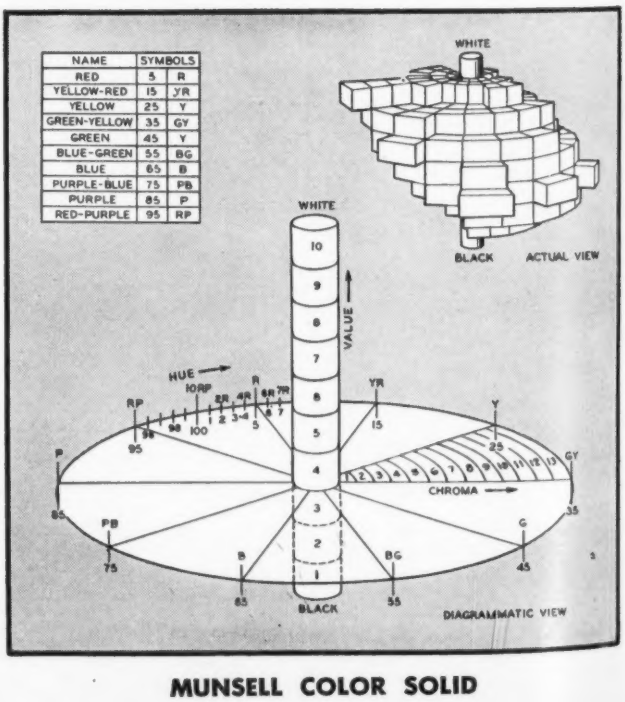
Various types of artificial light sources produce different color qualities of light. Even the color quality of daylight varies throughout the day and by geographical direction. Spectral distribution curves, which indicate the color, or "color quality", of an illuminant, thus become useful to the lighting engineer, since they indicate the amount of energy radiated at different wavelengths, or in different color regions of the spectrum. The white line superimposed on the full color spectrum (illustrated) is the spectral distribution curve for a 500-watt incandescent filament lamp. It will be noted that its radiant energy is greatest in the orange-red end of the spectrum, but that some energy is



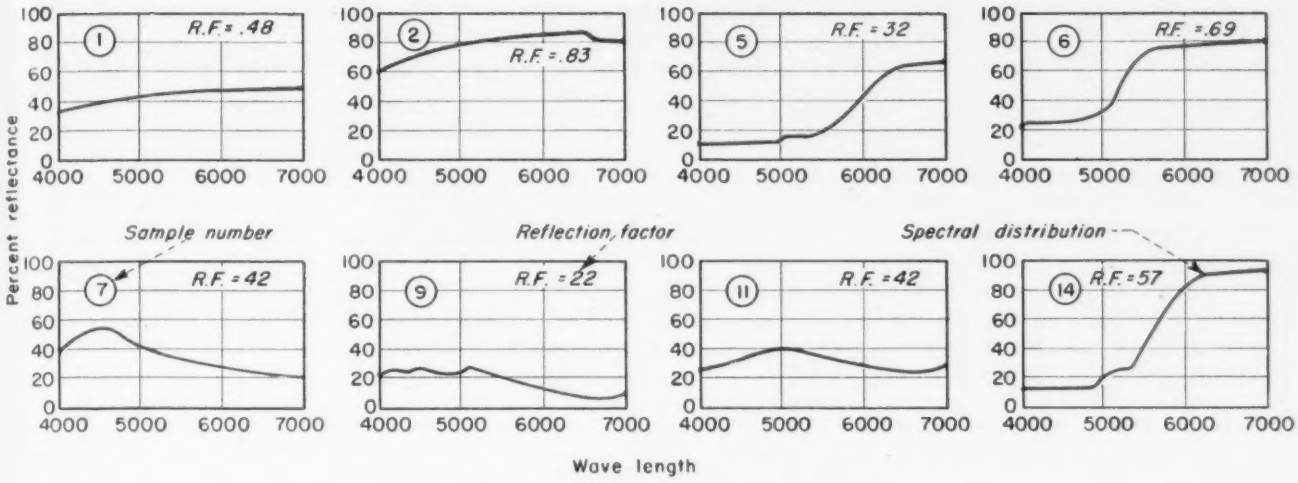
COLOR TEMPERATURE THERMOMETER AND I.C.I. CHART



I.C.I. COLOR DIAGRAM



MUNSELL COLOR SOLID



SPECTRAL DISTRIBUTION CURVES

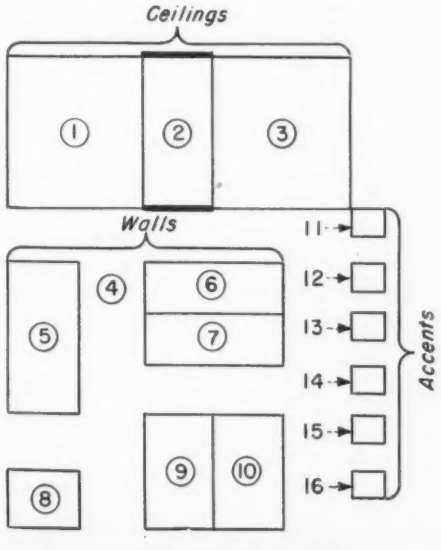
produced over the entire spectrum. This predominance of energy in the red end of the spectrum accounts for the "yellowish-orange" appearance of filament lamps, as compared with white light or daylight. The eye is not capable of distinguishing the many colors inherent in a light source, but groups the many hues into an apparent single color value which is represented by the spectral hue or color that it most closely matches.

Spectral distribution curves can also be made for colored surfaces such as fabrics, paint, wood, metal or plastic. In the full-color spectrum chart (illustrated) there is also shown a spectral distribution curve for a sample of blue paint (Arco Optomic Color No. 2 blue). This spectral distribution is represented by the black curve. As would be supposed, it peaks in the blue region. Comparing it with the spectral distribution curve for the 500-watt incandescent lamp, it is seen that the paint color complements the color quality of the light source. The paint thus helps to improve the color balance in lighting.

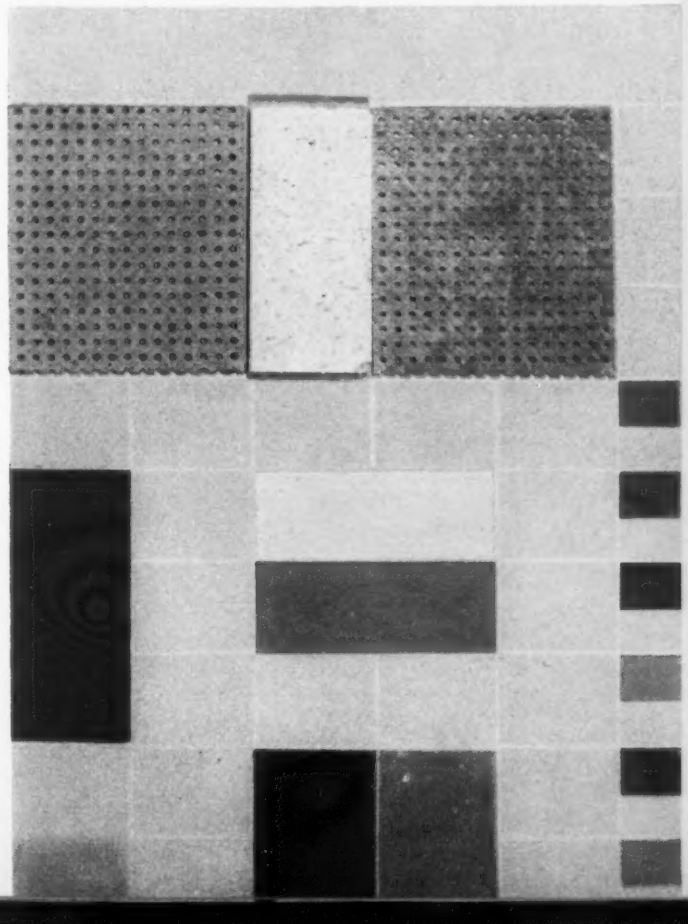
The chart, "Color Selections for Daylighting", shows paint color selections which improve color balance for daylighting in rooms with respect to their geographical location. For example, the warmth of "tan" complements the coldness of rooms located so as to receive daylight from the north sky, or "blue" complements the warmth of light from the sun or southern sky in a room having southern exposure. Paint colors which complement natural light in rooms with other exposures are also shown.

Reproduced in color at the bottom of this page are true color samples of several of the colors and finishes used throughout the new General Electric Lighting Institute, Nela Park, Cleveland. Spectral distribution curves for eight typical color samples are reproduced above. Reflection factor for each color sample, measured when lighted with 4500-degree fluorescent white, is also shown. The reflection factor is a measure of luminosity, and not an energy function. Luminous reflectance is usually the first color attribute to be selected for any type of interior, since both the efficiency of the lighting system and brightness-contrasts are affected by the luminous reflectance of surfaces throughout the area to be lighted.

As can be seen from the above discussion, colored light and colored surfaces are both inherent factors to some degree on every lighting installation, whether for utility or



KEY TO COLOR CHART



EFFECT OF VARIOUS ILLUMINANTS ON INTERIOR PAINT COLORS

Paint Color	Munsell Color Designation	Approx. Reflect. Factor*	Filament	Soft White Fluorescent	White Fluorescent	4500 White Fluorescent	Daylight Fluorescent
Cherry Red	5.0 R 4/14	.13	Brilliant Orange Red	Pinkish Red	Pale Orange Red	Yellowish Red	Light Red
Orchid	10.0 RP 7/8	.44	Light Pink	Dusky Pink	Gray Pink	Light Pink	Good Match (grayer)
Plum	10.0 RP 2/2	.04	Deep Orange Red	Reddish Purple	Dark Brown	Light Reddish Brown	Deep Bluish Purple
Chestnut Brown	7.5 YR 5/2	.19	Medium Yellow Brown	Pinkish Brown	Gray Brown	Light Brownish Gray	Light Gray
Peach	2.5 YR 8/4	.58	Pinkish Yellow	Light Pink	Light Yellowish Pink	Very Light Pink	Fair Match (lighter)
Orange	5.0 YR 7/8	.44	Bright Orange	Light Pink	Pale Yellow	Light Yellow	Gray Yellow
Canary Yellow	10.0 YR 7/8	.44	Orange Yellow	Light Orange Yellow	Greenish Yellow	Light Yellow	Fair Match
Light Yellow	2.5 Y 8/8	.58	Vivid Orange Yellow	Pinkish Yellow	Medium Yellow	Light Bright Yellow	Light Greenish Yellow
Sea Foam Green	7.5 GY 8/4	.58	Greenish Yellow	Very Light Gray	Weak Gray Green	Light Yellowish Green	Good Match
Jade Green	2.5 G 5/4	.21	Vivid Yellow Green	Pale Gray Green	Weak Yellowish Green	Yellow Green	Fair Match (lighter)
Light Blue	5.0 BG 7/4	.46	Light Yellowish Green	Light Bluish Gray	Weak Greenish Blue	Blue Gray	Fair Match (lighter)
Medium Blue	5.0 PB 5/10	.23	Blue Green	Weak Gray Blue	Purplish Blue	Light Gray Blue	Fair Match (lighter)
Silver Gray	2.5 Y 8/2	.57	Light Yellow Gray	Pinkish Gray	Light Brownish Gray	Very Light Gray	Bluish Gray

Samples under the five illuminants were compared with identical samples under a Macbeth Daylighting Unit (color temperature 7000°K). "Good Match" indicates that the color of the sample so designated most nearly matched the standard under the Macbeth unit. The footcandle intensity of all illuminants was approximately the same. The Munsell designations are approximate, and were determined under the Macbeth unit.

*For Standard ICI Illuminant C, representative of average daylight.

Source: Westinghouse Lighting Handbook.

decorative effect. Careful consideration should therefore be given to both the aesthetic and the functional phases of color as it relates to lighting. It may not always be possible at this stage of development in the science of color work to obtain spectral distribution curves for various paints, fabrics and interior finishes, or to have such curves made promptly. These curves are, however, generally available for light sources in data bulletins published by lamp manufacturers, in the new IES Lighting Handbook, and various other publications.*

Creating color harmony in design is a job for the artist. It is the job of the physicist and the engineer, however, to provide the technical basis for translating the conceptions of the artist into actualities. Thus, the lighting engineer, either consciously or unconsciously, becomes an application engineer in problems relating to color.

The chromaticity of a color is specified by dominant wavelength, purity and luminous reflectance (I.C.I. system for specifying color). A full color chromaticity diagram is illustrated herein. Each color seen by the normal human eye is represented by some point within this diagram, and it is stated by some authorities that there are perhaps 10,000,000 recognizable colors. (*Dictionary of Color*, by A. Maerz and M. Rea Paul contains over 7000 samples with color names based on historical origins and current usage). A color temperature "thermometer" (chromaticity of a completely radiating "black body" source) is also illustrated at the left of the chromaticity diagram. The outer horseshoe curve of the chromaticity diagram represents pure spectrum colors. All other colors are mixtures of various wavelengths of light and lie within the area of the pure color chromaticity curve. When all wavelengths of light are mixed in equal proportion, perfect white light results and is represented by a point in the exact center of the diagram. Intermediate points represent mixtures of white plus a given wavelength. Thus, a chromaticity diagram can be used as a "Fluorescent Lamp Color Mixing Nomogram", illustrated previously. It also permits the correlation of color temperature with color nomenclature, wavelength and saturation, as illustrated in the "I.C.I. Color Diagram" (illustrated). In this diagram the dotted curve represents the color temperature "thermometer".

A typical color problem faced by the lighting engineer on practically every planned lighting layout is that of selecting the correct illuminant, so that colors of ceilings, side walls, floor coverings, decorative fabrics and interior furnishings will appear in their "natural" colors. The "natural" color is commonly accepted as that of its appearance under average daylight. The Table above shows the effect which various commonly used illuminants have on some of the more popular types of paint colors. These colors have been related to the Munsell system of color designation, as shown in the second column.

All color surfaces, whether paint, food, vegetables or other, should be considered when selecting an artificial illuminant.

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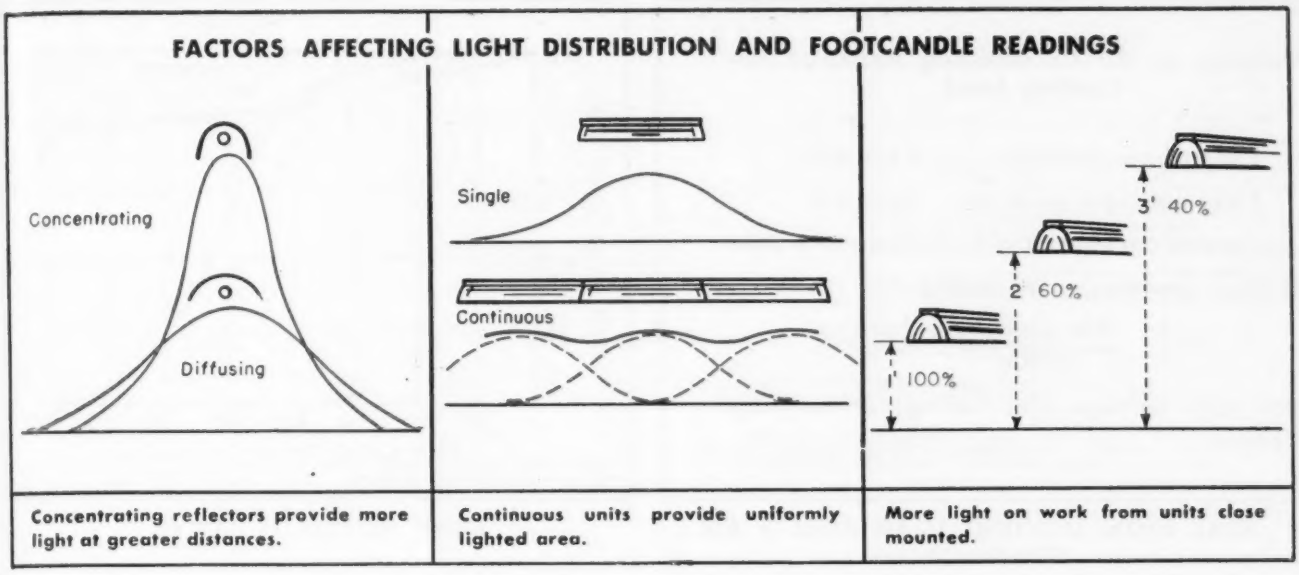
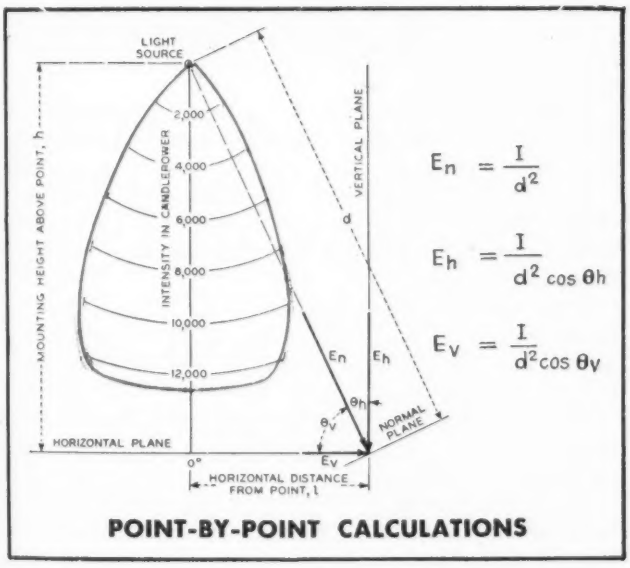
* *(Fluorescent Lighting Manual, Second Edition, by C. L. Amick, Chapter VIII. Published by the McGraw-Hill Book Company.)*.



SUPPLEMENTARY LIGHTING



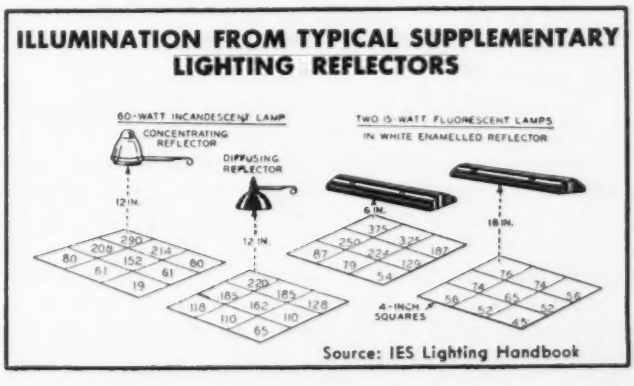
PLANNED LIGHTING

SUPPLEMENTARY lighting is used when seeing tasks require illumination levels in excess of values which are economical for general lighting. Current practice is to provide up to 100 footcandles of general lighting throughout an area, and to provide higher intensities, ranging up to 500 footcandles, over small work areas with supplementary type reflectors installed close to the areas. In those areas where lighting levels are below 50 footcandles, supplementary units are also used to provide intensities in excess of this value.

Concentrating reflectors attached to adjustable brackets and mounted on machines or benches are desirable for providing intensities of 200 to 300 footcandles. Such intensities should be provided only for objects having low reflection, and where general lighting levels are on the order of 50 footcandles or above, since local spots of high intensity in relatively dark areas can and usually do result in glare. Continuous row diffuse reflector type fluorescent units are ideal for bench lighting or for fine parts assembly lines. These units may be mounted directly over the work area, but care should be used to shield the light sources from the workers' eyes.

The point-by-point method of calculation is useful in determining estimated intensities from individual supplementary type reflector units. It is necessary, of course, to have a candlepower distribution curve of the reflector being considered. The intensity may then be calculated for a point at any angle from the center axis, or on the axis, using the formulas shown in the illustration at the left.

Supplementary lighting units have many applications, in industry, stores, public buildings, the office and in the home. Many types of units are available, both for incandescent and fluorescent lamps. Four typical types, and footcandle values for a small area at specified distances which result from each type are shown in the illustration below.



Calculation of Air Conditioning Required for Lighting Load

1 Watt hour produces 3.414 BTU

1 Kilowatt hour produces 3414 BTU

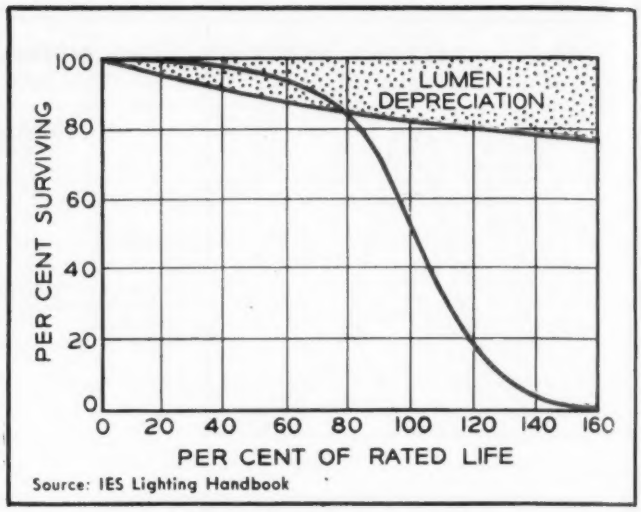
BTU generated per hour = Lighting kilowatts* x 3414

Tons of air conditioning required =

$$\frac{\text{BTU per hour}}{12000}$$

*Total lamp wattage plus wattage of auxiliary equipment.

HEAT FROM LIGHTING LOAD AFFECTS AIR CONDITIONING



LAMP MORTALITY CURVE

PLANNED LIGHTING

LIGHTING

EVERY lighting engineer should know how to determine lighting costs for the various types of lighting systems. He should also be able to make cost comparisons between the various ways of solving a specific lighting problem.

Most lighting customers use cost as a basis for appraisal when they discuss a new lighting installation. They want to know what the initial or first cost of the installation will be, and how much it will cost them to operate it. If the customer is considering more than one type of installation he is interested in comparative costs between the various types under consideration. It is only natural, therefore, that the lighting engineer best qualified to make an intelligent appraisal of all factors involved in the economics of the lighting installation will be the one to sell the best quality job from a lighting appraisal viewpoint.

The economics of lighting embrace various factors, some of which cannot be appraised on a dollars-and-cents basis. Appearance and quality of the lighting result fall into this classification. Certainly it would be very difficult to put a cost value on the appearance of the lighting in a highly decorated night club, restaurant or cinema auditorium, in which light is used as the decorative medium or to form a part of it. Likewise, it is difficult to appraise the appearance of the lighting installation on a cost basis in a store, office, classroom or even in an industrial area where decorative treatment is given less consideration.

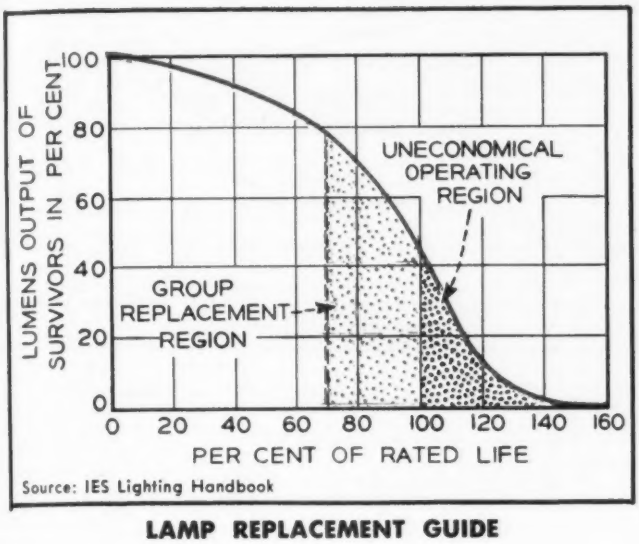
The quality of the lighting is equally difficult to appraise in items of cost. Yet lighting quality, which in a sense is a measure of seeing comfort, lack of glare, and proper brightness-contrast and color quality of the resultant illumination, is a major factor in the appraisal of any lighting installation. Too much emphasis should therefore not be placed on cost analysis without putting equal or proportionate emphasis on aesthetic values and quality of the illumination result to the extent that they play a part in any lighting system appraisal.

In making a cost analysis for any specific lighting installation, it is common practice to divide costs into two groups, one group to include *fixed charges,* the other, ***operating charges.*** Fixed charges cover the initial cost of the installation, while operating charges cover the cost of electrical energy, lamp and defective parts replacements and maintenance.

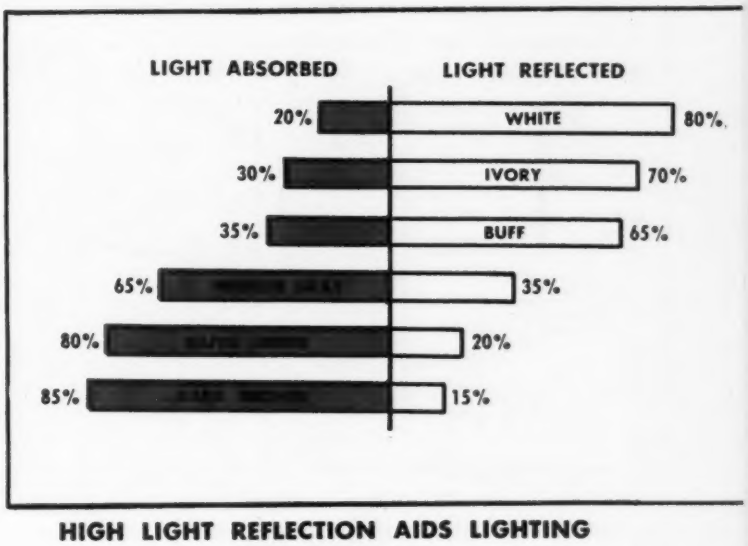
There are differences of opinion on how to amortize fixed charges. This amortization, which is normally an annual rate of depreciation, must be decided upon before it is possible to arrive at an "annual cost of light", in which the customer is primarily interested. Some lighting engineers believe that the fixed charges should be written off in a short period of time, from five to eight years. They maintain that the rapid advances being made in lighting will obsolete today's most outstanding lighting installation in that period of time, especially in stores, restaurants, night clubs, theatres, hotel lobbies and ballrooms, and similar areas which depend upon frequent modernization and redecorating to attract and hold the public's interest.

Other lighting engineers believe that a well planned modern lighting installation should be amortized over a longer period of time. They use from ten to 15 years as a basis for depreciating the fixed charges. They maintain that the majority of recently relighted offices, schools and factories were previously lighted with the same old system for from twelve to 20 years.

Perhaps the wisest procedure is to discuss the rate of amortization with the customer, and to base depreciation allowances on the customer's own method of accounting procedure. When this is not feasible, the following basis is recommended for determining "yearly owning cost," including depreciation, interest on the declining principal, taxes, insurance and repairs. For installations which are subject to frequent changes in decorating, such as stores, restaurants, night clubs, etc., use 20 percent of the initial first cost as the yearly owning cost. This will roughly average



LAMP REPLACEMENT GUIDE



HIGH LIGHT REFLECTION AIDS LIGHTING EFFICIENCY

ECONOMICS

an eight-year write-off for the entire installation. For offices, schools, factories and similar installations not subject to frequent redecorations or modernizations, use 15 percent of the initial first cost as the yearly owning cost. This figure will roughly represent a twelve to 13 year write-off for the entire installation.

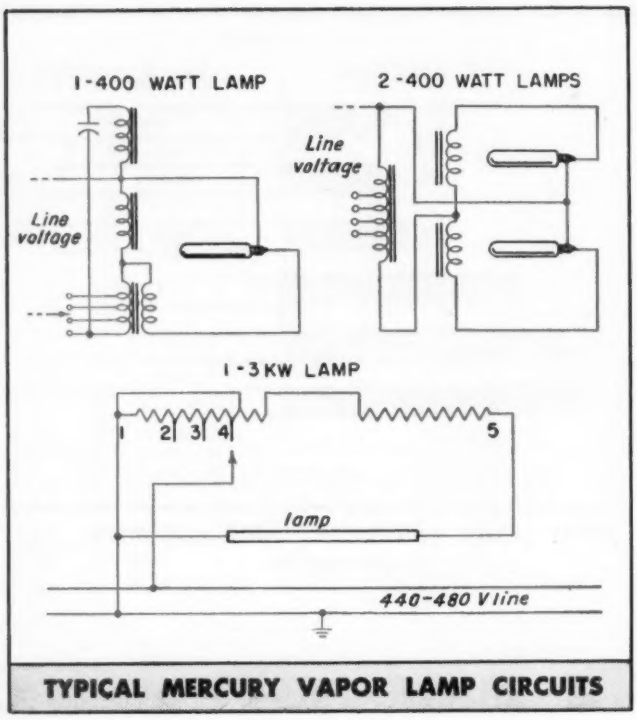
In estimating the initial cost of a lighting installation, it is sometimes difficult to decide just what should be included as making up the installation. The contractor sometimes lists "lighting equipment" as one item, "wiring" as another, and "installation" as still another, in working up his bid, or in submitting his bill, especially when working on a time-and-material basis. The cost of the "lighting equipment" in this case should not be considered as the total initial cost of the lighting installation when attempting to make an accurate cost comparison between installations.

For purposes of cost comparisons, there are many factors to be considered. The reasons will be apparent from the following discussion. It is considered that the following factors are all pertinent, depending on the type of lighting system used, and whether or not these factors are involved on the project. Items which should be included as part of the lighting installation are listed below.

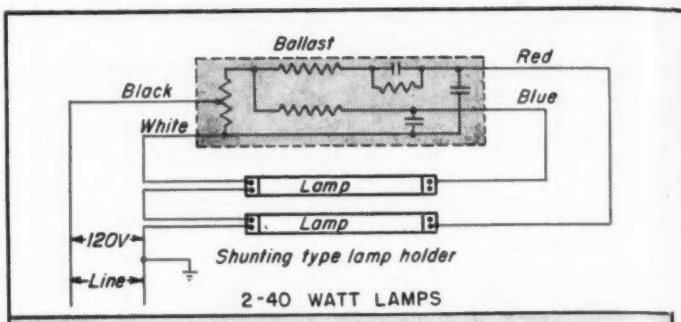
1. *Total cost of all luminaires or lighting equipment.* In the case of cove lighting or other special applications, the cost of wiring channel, reflectors, color lenses, or other special equipment of this type should be included.
2. *Total cost of all wiring.* This should include all wiring materials, such as conduit, wire, switches, boxes, panels, feeders and transformers, including labor for installing. Where transformers or distribution systems are also used for power loads, the cost of these items should be proportioned between power and lighting.
3. *Proportionate cost of air conditioning required to dissipate lighting load.* Obviously, this will apply only when air conditioning is used. It will affect lighting installation costs for comparison purposes only when there is a substantial difference in lighting load, such as incandescent lamps versus fluorescent lamps.
4. *Construction cost differences due to the lighting installation.* The installation of coves, coffers, soffits, troffers, louvered ceilings, luminous ceilings and other forms of recessed or built-in types of equipment may involve structural changes or special construction. These costs cannot logically be classified as lighting installation costs, but the differences in construction costs should be applied to the lighting installation costs for purposes of comparison of one lighting system with another.

Operating charges include the net cost of lamps and starter switches used for replacement, the cost of electrical energy, including demand charges where they exist, and cleaning and maintenance costs. Large users of lamps usually purchase lamps at a discount on a contract basis, and net costs should be used. Electrical energy rates and demand charges can be obtained from the local electrical utility company. It is also a simple matter to work up a table of "annual operating costs" for a specific lighting load based on different rates of cost per kilowatt-hour for the electrical energy. Cleaning costs based on different cleaning frequencies per year may also be combined in the same table. Repairs and replacements of ballasts, starter switches, lampholders, glassware, plastic diffusers, etc., are considered maintenance items, and therefore part of the annual operating cost.

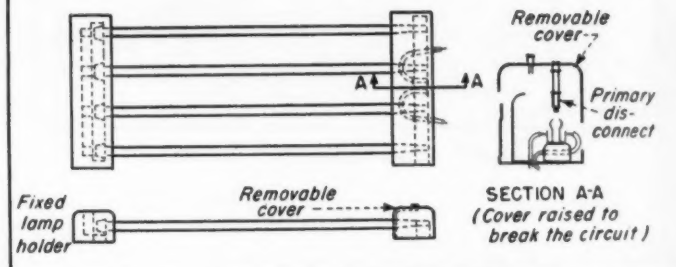
The cost of lamps represents a very small part of the cost of producing light, usually less than ten percent. It is therefore economical to replace lamps when they have reached the end of their rated life, since energy will be used which does not produce any light due to lamp lumen depreciation. The finishes of ceilings, walls, floors, furniture and machinery also affect lighting efficiency, as shown by the coefficient of utilization tables. Proper reflectance of paints and finishes and their maintenance can be justified easily by cost analysis, comparison of the area being considered when lighted to the desired intensity, but painted in finishes of varying light reflection values.



TYPICAL MERCURY VAPOR LAMP CIRCUITS



Instant-Starting



Cold Cathode Safety

LIGHTING COMPONENTS

PLANNED LIGHTING

INCANDESCENT or filament lamps are easily adapted for use in luminaires or reflector equipment. All that is required is a lampholder, or socket, and wire. Sockets are usually simple in design, and for standard type lamps used for general lighting, are either medium screw base, mogul screw base or mogul bi-post base. Adequate mechanical strength, proper electrical characteristics, and ability to withstand the amount of heat generated by the lamps constitute the main requirements for these accessories.

Fluorescent and mercury vapor lamps are forms of "electric discharge" light sources. Thus, they require auxiliary equipment for their operation, commonly referred to as "ballasts" for low voltage (preheat cathode) lamps, or "transformers" for high voltage (cold cathode) lamps. Variations in diameter and length of lamps, and in type of electrodes used, make it necessary to provide many sizes and types of ballasts, or transformers, each size and type being specifically designed to meet the specific requirements for each size, number and type of lamp. This accounts for the large number of types of ballasts or transformers which are available.

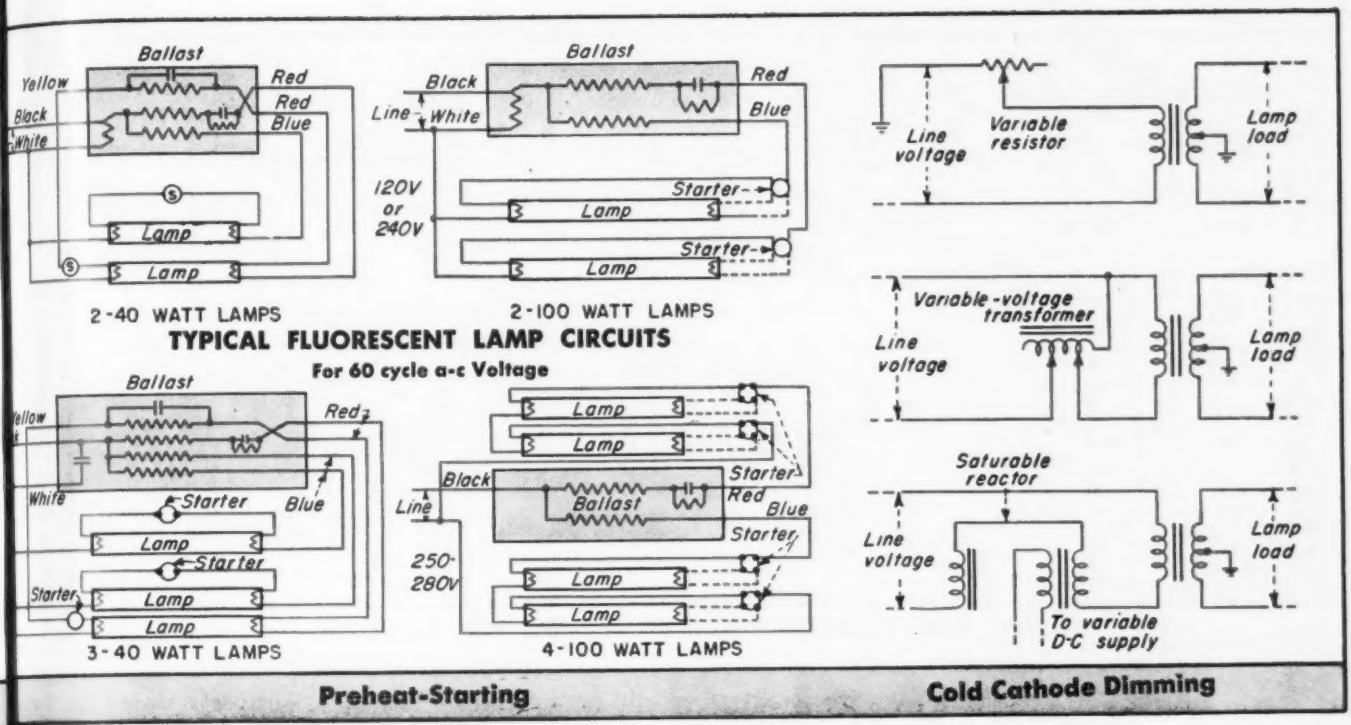
In the Table on next page are listed those ballasts most commonly used with standard preheat-cathode fluorescent lamps. Other types are also available from the various transformer manufacturers, for use with single lamps, also for use with slimline, circular and cold cathode type lamps. Ballasts consume electrical energy, which load must be taken into account when estimating the efficiency of a lighting system, and when making the wiring layout. These losses vary considerably with relation to the lamp wattages controlled, as may be readily seen in the Table. It is therefore important to consider the type of ballasts which will provide the maximum efficiency in combination with the size of lamps proposed for each lighting application.

High power factor ballasts offer four distinct advantages over low power factor types, and should be used on all general lighting applications. These advantages are: 1) line current is kept normal and less circuit capacity is required; 2) additional lamps may be installed on many existing circuits; 3) voltage conditions are improved; and 4) the load on generating equipment is reduced.

Starter switches are required for preheat-cathode fluorescent lamps. These switches are used to first preheat the cathodes and then to quickly open the circuit to permit the inductive kick to start the lamp. Shown opposite are four automatic types of starter switches. These are of the replaceable type. They are made in several sizes and types to meet the different characteristics of the various lamp sizes with which they are designed to be used.

Lampholders for fluorescent lamps are made in a variety of types and for different methods of mounting. They are classified as miniature bi-pin for small wattage lamps, medium bi-pin for 15- to 40-watt lamps, and mogul bi-pin for 100-watt lamps. In addition there are slimline lampholders, circular lamp lampholders and cold cathode lampholders. Typical types are shown on the next page.

Wiring diagrams for some of the more popular types of ballasts and transformers for use with standard fluorescent and mercury vapor lamps are shown above.

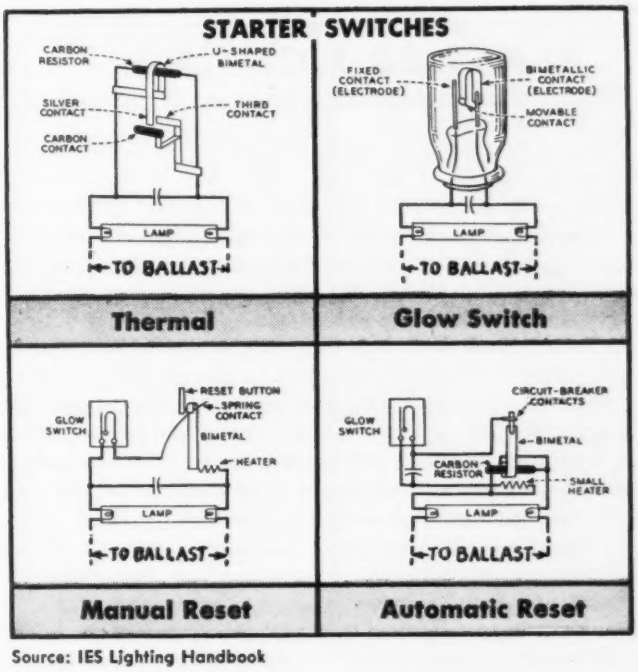


LAMP WATTS	WEIGHT, POUNDS	LINE CURRENT	WATTS LOSS
For 60 cycle, 110-125 Volt Circuits			
2-15	3¼	0.35	9.0
2-20	3¼	0.45	9.0
2-30	7	0.70	12.5
2-40	7	0.85	15.5
3-40	11	1.30	23.0
2-100	14½	2.10	32.0
For 60 cycle, 199-216 Volt Circuits			
2-30	7	0.40	10.0
2-40	7	0.50	11.5
3-40	9¾	0.70	16.0
2-100	14½	1.25	32.0
For 60 cycle, 220-250 Volt Circuits			
2-30	7	0.35	10.5
2-40	7	0.43	12.5
3-40	9¾	0.60	20.0
2-100	14½	1.10	32.0
For 60 cycle, 240-280 Volt Circuits (For Y-connected networks, line to neutral)			
2-40	7	0.40	15.0
3-40	10¼	0.60	20.0
2-100	15	1.00	35.0
4-100	17½	1.65	36.0

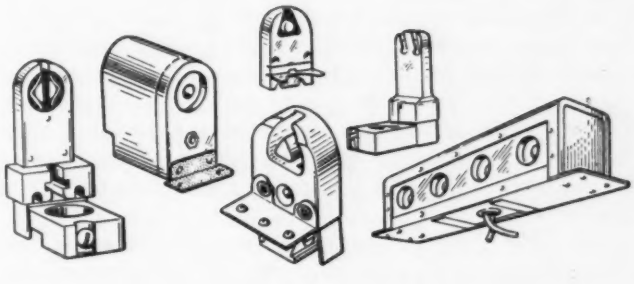
* Reference data given is for standard high power factor ballasts of standard cross-section type, designed for use with the number of lamps of wattages as listed. For dimensions and other data on these ballasts, and for information on other type ballasts, manufacturers' catalogs should be consulted.

Source: General Electric Company Bulletin LD-1.

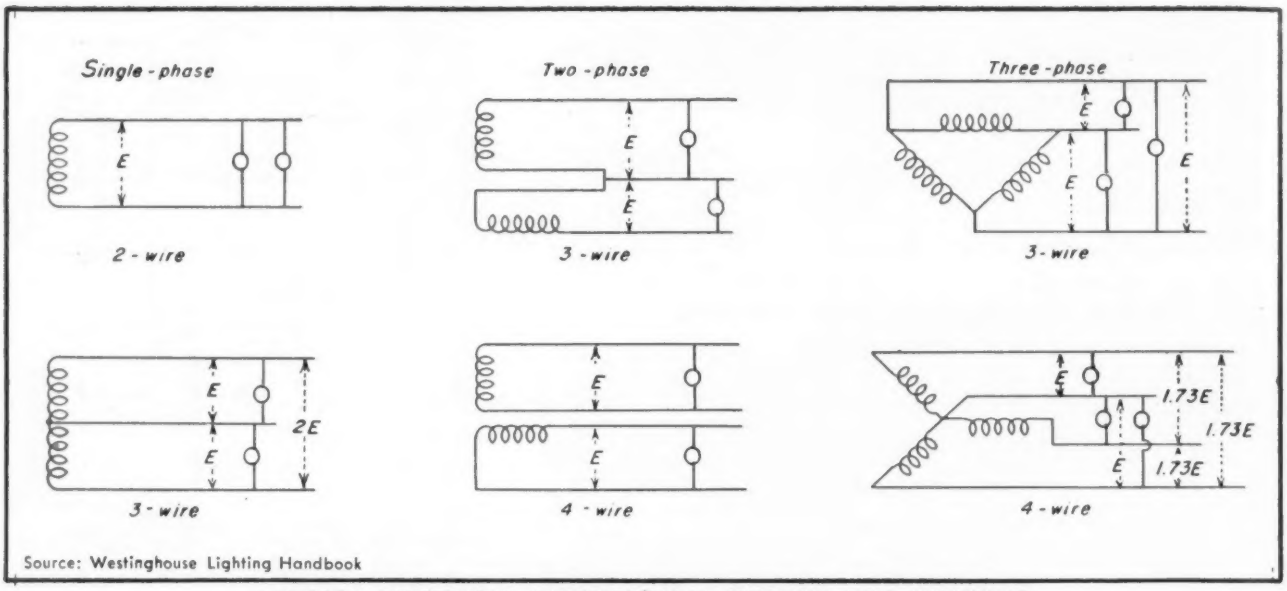
TYPICAL FLUORESCENT LAMP BALLASTS*
For General Lighting



Source: IES Lighting Handbook



TYPICAL FLUORESCENT LAMPHOLDERS



Source: Westinghouse Lighting Handbook

TYPICAL ELECTRICAL DISTRIBUTION SYSTEMS FOR LIGHTING

WIRING FOR LIGHTING

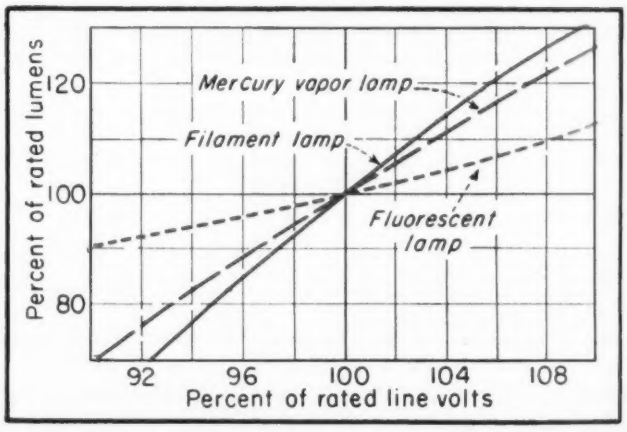
PLANNED LIGHTING

A CAREFULLY planned lighting installation deserves a well planned wiring system. The lighting plan cannot be considered complete until the wiring system and controls have been carefully studied and made a part of the plan.

The National Electrical Code, which is supplemented in many localities by local codes and regulations, is written as a guide to safety in wiring systems. The requirements set up by this Code and the various local codes are based on minimum requirements for safety. In an effort to reduce costs to a bare bones basis, the majority of wiring systems for lighting fail to meet the requirements of adequacy for maximum efficiency and trouble-free operation of the lighting system. In most instances the most economical wiring job for the owner will far exceed the minimum requirements established by codes.

The wiring system should be designed so that full rated voltage exists at the socket for incandescent lamps, or at the ballast lead connections for mercury vapor or fluorescent lamps, when full load is applied. Any decrease in applied voltage results in a decrease in light output and change in color quality on incandescent lamps. Only when full voltage is supplied can the owner get the full amount of light he pays for in energy consumed by the lighting system (see chart, "Adequate Wiring Increases Light Output").

The 110-125 volt range is not always the most economical voltage range for fluorescent or mercury vapor lamps. For example, the lumens per watt for 40-watt fluorescent lamps operated on a 3-lamp ballast designed for 110-125 volt range is 48.2 lumens per watt, taking into account the watts lost in the ballast. When 40-watt fluorescent lamps are



ADEQUATE WIRING INCREASES LIGHT OUTPUT

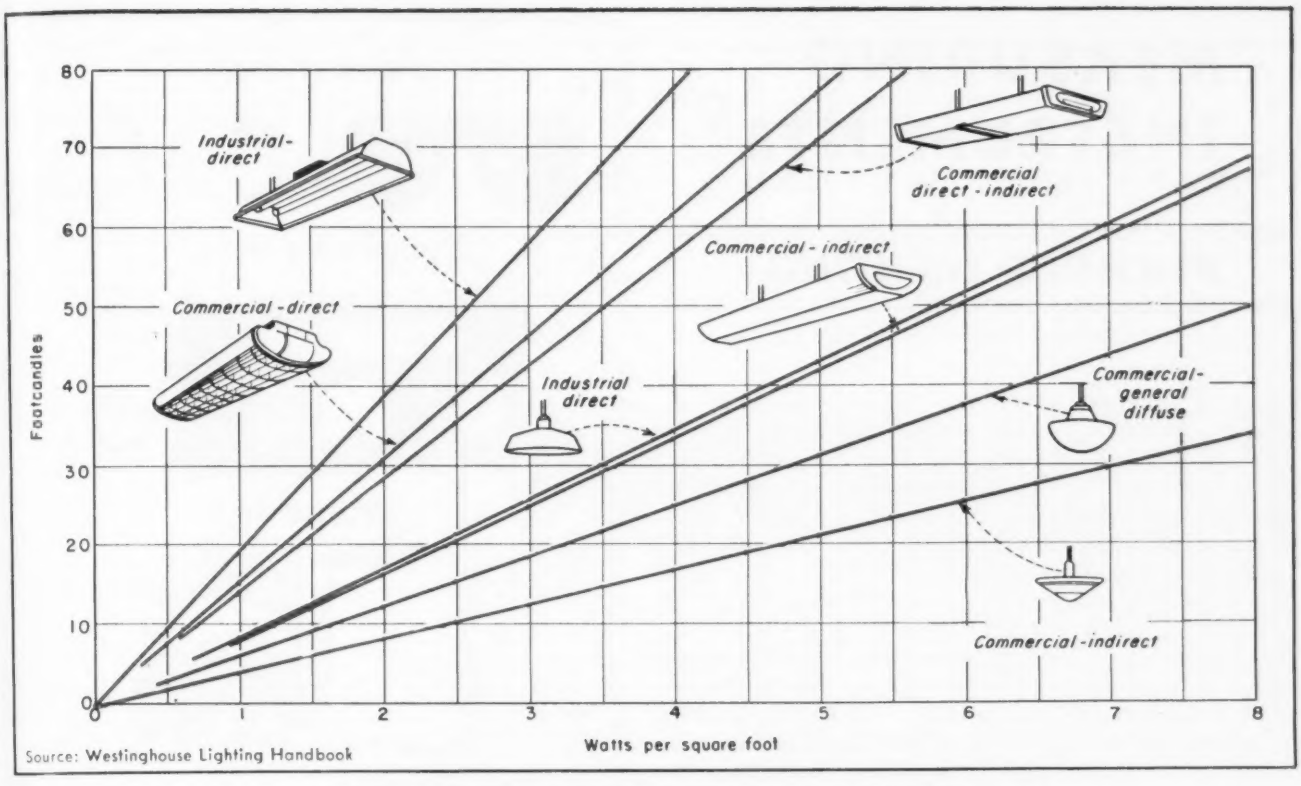
Source: Westinghouse Lighting Handbook

MORE LIGHT WITH HIGH POWER FACTOR BALLASTS

Capacity of 15-ampere 115-volt branch circuit

Size lamp (Watts)		15	20	30	40	100
FLUORESCENT						
Watts loss per ballast*		4.5	4.5	9.0	9.5	24.0
Total permissible watts	90%	1550	1550	1550	1550	1550
Number of lamps	P. F.	79	63	39	31	12
Permissible lamp watts		1185	1260	1170	1240	1200
Watts loss per ballast*		4.5	4.5	9.0	9.5	24.0
Total permissible watts	55%	950	950	950	950	950
Number of lamps	P. F.	48	38	24	19	7
Permissible lamp watts		720	760	720	760	700
INCANDESCENT						
Permissible lamp watts	Unity P. F.	1725	1725	1725	1725	1725

*Approximate watts loss for single lamp ballasts rated 110-125 volts, 60 cycles



Source: Westinghouse Lighting Handbook

WIRING CAPACITY LIMITS LIGHTING INTENSITIES

FLUORESCENT LAMP LUMENS PER WATT
After Adding Ballast Watts Loss

Type of Ballast	Approx. Watts Loss	Total Lumens	Lumens* per Watt
	110-125 VOLT RANGE		
1-40	9.5	2300	46.5
2-40	15.5	4600	48.2
3-40	23.0	6900	48.2
1-100	24.0	4200	33.9
2-100	32.0	8400	36.2
	199-216 VOLT RANGE		
1-40	8.5	2300	47.5
2-40	11.5	4600	50.3
3-40	16.0	6900	50.7
1-100	30.0	4200	32.3
2-100	32.0	8400	36.2
	220-250 VOLT RANGE		
1-40	9.5	2300	46.5
2-40	12.5	4600	49.8
3-40	20.0	6900	49.3
1-100	30.0	4200	32.3
2-100	32.0	8400	36.2
	240-280 VOLT RANGE		
2-40	15.0	4600	48.5
3-40	20.0	6900	49.3
2-100	35.0	8400	35.7
	250-280 VOLT RANGE**		
4-100	36.0	16800	38.5

Approximate watts loss is based on high power factor 60 cycle ballasts.
*Total lumens are based on 3500-degree white fluorescent lamps. Lumens per watt is the ratio of total lamp lumens generated to lamp wattages plus watts loss in ballasts.
**For use on Y-connected network distribution system rated at 254/440, 265/460 or 277/480 volts. Source: Based on data from General Electric Co. Bulletin LD-1, May 1946.

operated on a 3-lamp ballast designed for the 199-216 volt range, the efficiency is increased to 50.7 lumens per watt. The higher voltage range also reduces the line current from 1.30 amperes for the 110-125 volt range to .70 amperes for the 199-216 voltage range. When the same size conductors are used, there will be less voltage drop on the higher voltage range, and greater efficiency in light output.

On new wiring installations, a careful analysis should be made to determine which type of electrical distribution system will most adequately meet the needs of the lighting load. Six typical electrical distribution systems for lighting are shown at top of the page opposite. The single-phase two- and three-wire systems are normally used for small lighting loads, while the three-phase four-wire system is commonly used for large lighting loads. Full analysis of the distribution problems for each lighting installation, particularly where fluorescent or mercury vapor lamps are used, may indicate economies for higher voltages, or a change in the type of distribution system.

The chart at the top of this page will be useful in determining lighting levels which may be expected from various types of luminaires on relighting installations where the wiring is already installed. A check of the wiring system will indicate the "watts per square foot" capacity available. Using this value in the chart, it is easy to determine the "footcandles" which a particular type of luminaire will produce, or to determine what type of luminaire will produce the desired level of illumination. This chart should be used as a rough guide only, after which a more accurate check should be made by computations as previously outlined.

The importance of using high power factor ballasts on either a new installation or a relighting job is shown in the Table at the bottom of opposite page. The "permissible lamp watts" on any circuit will be considerably less, when low power factor ballasts are used, thus decreasing the amount of light which may be produced.

MEASURING INSTRUMENTS

PLANNED LIGHTING ○

THE illuminating engineer today must have an appreciation of art, as well as of science. He must be able to recognize various periods of architecture and decoration. He must have a sense of color harmony, and understand psychological and physiological reactions to various color schemes. Such appreciation is usually developed through experience and observation.

On the scientific and technical side of lighting, much progress has been made in recent years. Continuous research and studies on the "Science of Seeing" by the research laboratories, and by many renowned researchers have developed scientific and technical data and adequate information to enable lighting engineers to predetermine lighting intensities and lighting results to a remarkable degree of exactness.

Good lighting still has to be sold, however. Lighting customers "have to be shown". First, they have to be shown why their present lighting is inadequate. Second, they want to see for themselves what lighting improvements result from relighting, or what they receive for their money on new lighting installations. Portable type measuring instruments have been developed for field use and are available for this purpose.

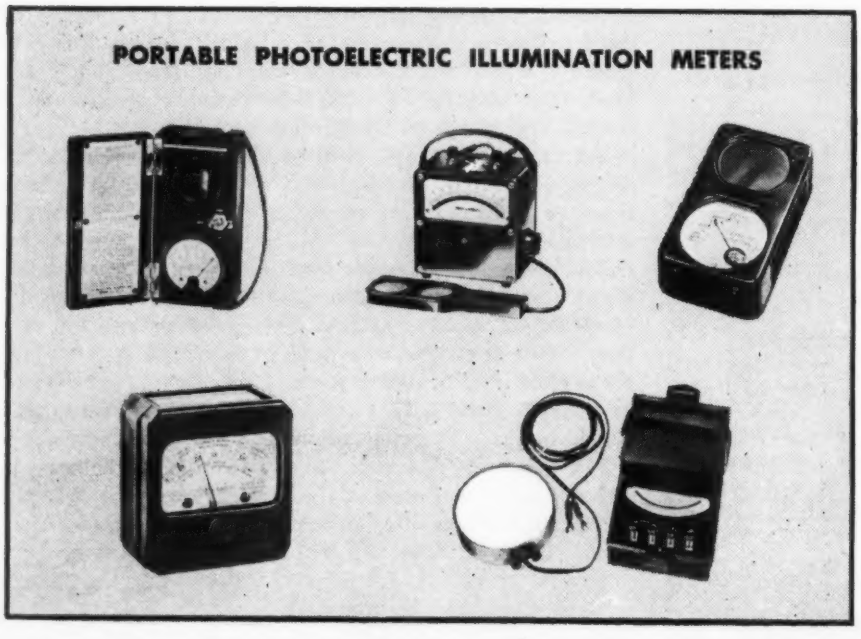
The most common type of measuring instrument for the application lighting engineer is the footcandle meter. It measures lighting intensities in "footcandles" directly on a footcandle scale. Such instruments are variously called "footcandle meters", "light meters" and "illuminometers".

They are portable instruments, and use light-sensitive photoelectric cells. While the spectral response of these photoelectric cells does not coincide with the light sensitivity curve of the eye, these meters are adequate for general commercial use when light source correction factors, which are available from the various meter manufacturers, are applied to readings obtained under any specific type of light source. Several types of available light meters are illustrated below.

Other important measuring instruments for the illuminating engineer, which aid him in analyzing the lighting problem or lighting result include the visibility meter, brightness meter and voltmeter, all illustrated above.

It is important to record impressed voltage at the lamp or at the ballast when making footcandle intensity readings, if an intelligent analysis of the efficiency of the lighting system is to be expected. The voltmeter is therefore considered an important measuring instrument for the lighting engineer. It should be of the portable type and equipped with two scales, one to indicate voltages up to 150 volts, the other to indicate voltages up to 300 volts. To be of real value, every lighting report showing footcandle intensities should also show the impressed voltages existing when the footcandle readings were made.

The above instruments are considered necessary tools for obtaining complete information on lighting installations. They are primarily for use by the application lighting engineer in making field reports covering either old or new lighting jobs. Data thus obtained is germane to all *Planned Lighting* applications.



HOW

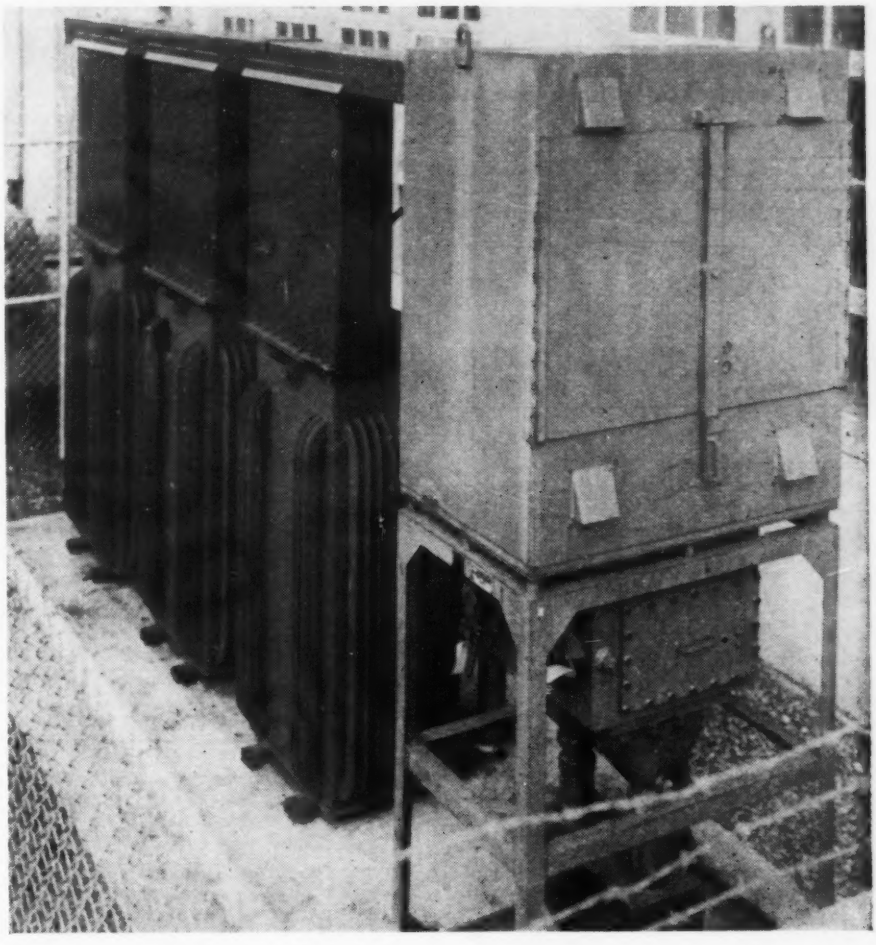
DESIGN • CONSTRUCT • OPERATE • MAINTAIN

Primary Transformer Connections Metal-Clad

O. O. RANDS, Electrical Engineer
12th Naval District, San Francisco

IN A RECENT installation of three 12,000/480-volt substations at the U. S. Naval Air Station, Moffatt Field, Calif., it was found necessary to make use of existing outdoor cover bushing type transformers. In order to eliminate the hazard of conventional open primary bus connections, it was decided to completely enclose the high-tension bushings and connecting leads in sheet metal housings as illustrated.

As may be seen, these housings were carefully fitted to the transformers and carried over in gutter to the primary switchgear. Housings were made completely weatherproof with removable covers to provide access to the transformer terminals. With transformers and switchgear of this type, the metal-clad high-tension enclosures made a very neat and safe installation.



ENCLOSED high-tension bushings and transformer leads combine safety with neat appearance on bank of three 200-kva, 12,000/480-v transformers

Supervision Improves Cable Splicing Operations

A WORK-RECORDING SYSTEM for supervising cable splicing is used by an eastern utility that serves between 50,000 and 75,000 customers. The procedure assures accurate and complete progress reports for this type of work.

Each splicer turns in a report for each day worked. The time of arrival, starting, and stopping work at the job-site is recorded, and all splices are listed. Splices are recorded only when finished. The general line foreman keeps a record of the total splices made each week and each month as classified on the individual splicers' reports.

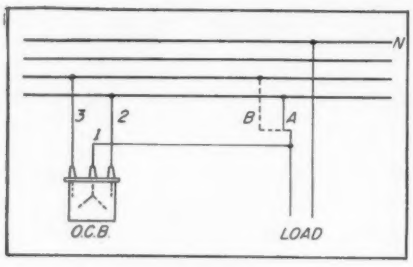
When a splice is completed, the splicer stamps his assigned initial and the last two figures of the current year in the wipe at each end of the splice. This is done with a steel stamp and is easily readable. Initials cannot be changed without permission of the distribution superintendent.

To improve public relations, cable splicers and helpers are reminded that they are under constant observation by the general public when working. They must present an alert and businesslike appearance at all times. When a splicer is in a manhole, his helper is forbidden to leave the immediate vicinity. The helper is expected to observe the actions of the splicer, especially where work is being done on live conductors. He must be ready to render prompt assistance when required. Bystanders are discouraged from loitering near the manhole, and idle conversation with them is avoided.

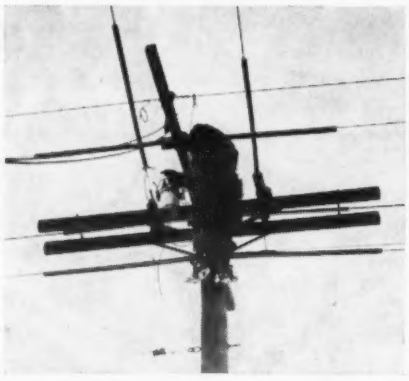
Transfer Single-Phase Load Without Interruption

F. E. WILTERDING
Supt Electrical Construction
Wisconsin Electric Power Co
Milwaukee, Wis.

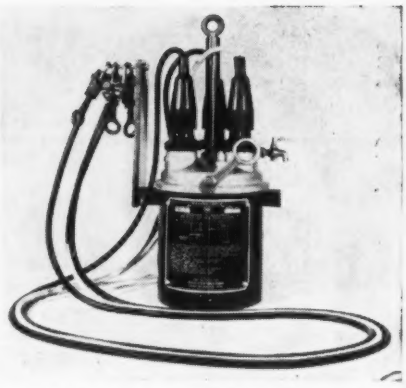
REARRANGEMENT of feeders and transfers of single-phase branch lines and transformers to maintain load balances and voltage control on three-phase circuits require frequent transfers and cutovers from one phase to another. An especially designed portable oil switch outfit used by Wisconsin Electric Power Co overhead line crews has practically eliminated both the hazard and the outage of this operation.



LOAD is carried through one side of the double-throw switch (lead 2) while the jumper A is removed. Quick break transfers load to new phase (lead 3) and jumper B can then be connected



PORTABLE oil switch mounted temporarily at pole top for transfer of single-phase load connections



SPECIALLY DEVELOPED transfer switch has flexible leads and hook clamps for connection to line wires

The lightweight switch is single-pole, double-throw, quick-break and has three insulated flexible leads with hook clamps for quick connection and disconnection. As shown in the accompanying diagram, the switch is connected to the phases and the load line. The double-throw action makes the actual load transfer in one cycle or less. The total line crew time for each cutover operation is about nine minutes, plus the time needed for placing protective rubber goods as needed.

This switch is also used for cutting in boosters and voltage regulators without service interruptions and for picking up loads after repairs to broken wires. The capacity is 100 amp at 5,000 volts.

• • •

Box and Paddle Silverplates Blades and Clips

M. D. POLLOCK
Valley Stream, L. I., N. Y.

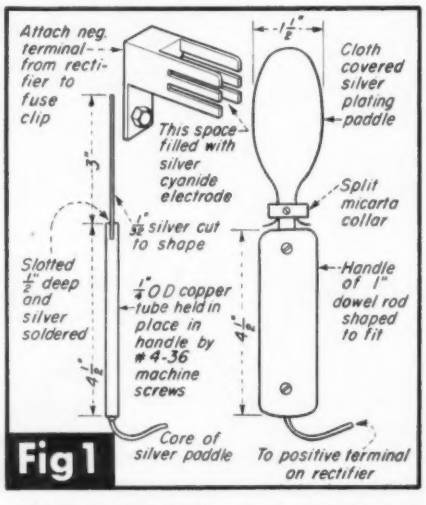
A PLATING BOX and paddle have been specially designed for fast and easy silverplating of fuse and switch blades of 100-amp sizes and larger.

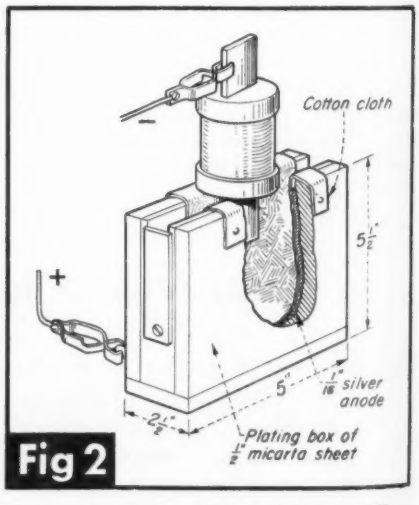
The box, shown in Fig 1, is made of $\frac{1}{2}$-in. Micarta and assembled with machine screws. Sheets of 99 percent pure commercial silver, $\frac{1}{16}$ in. thick, are tacked to the Micarta on the inside of the box. Two layers of loosely woven white cotton cloth, dampened with water, cover the silver sheets. The cloth prevents shorting with the blade and permits easy penetration of the electrolyte of silver cyanide paste.

A copper-oxide rectifier and a transformer with 2 to 10-v taps at 10-amp maximum output is used to provide plating power.

Copper to be plated must be cleaned thoroughly with polishing compound, carbon tetrachloride, nitric acid or soap and water. After cleaning, the copper must not be touched by the plater's fingers unless they are rubber covered.

With the plating box in place and the work thoroughly covered with electrolyte, the circuit is closed and the current applied at a voltage just high enough to prevent burning. Depending on the condition of the elec-


Attach neg. terminal from rectifier to fuse clip
1½"
Cloth covered silver plating paddle
This space filled with silver cyanide electrode
3"
Split micarta collar
½" silver cut to shape
Handle of 1" dowel rod shaped to fit
Slotted ½" deep and silver soldered
¼" O.D. copper tube held in place in handle by #4-36 machine screws
4½"
4½"
Core of silver paddle
To positive terminal on rectifier
Fig 1



PLATING BOX (Fig 1) for knife-blade type fuses and switches. Silver-plating paddle (Fig. 2) for use on knife-switch clips. A copper-oxide rectifier and a transformer with 2 to 10-v taps at 10-amp max output provides plating power

PRICES REDUCED...

on most

G-E CIRCLINE BALLASTS

Prices on General Electric's famous Circline ballasts have been reduced as much as 20 per cent. The table below shows where these reductions have been made and their extent. Stepped up production and more efficient manufacturing tools have made these reductions possible.

Ballasts are available for both the 12-inch, 32-watt and the 8¼-inch, 22-watt Circline lamps. They are designed in uncorrected or high-power-factor ratings for single lamps, and for high-power-factor Tulamp operation. Ballasts are made in rectangular design, and in the disk-shape design which lends itself to mounting in the base of a lamp or to concealment in shallow wall or ceiling fixtures. Bulletin GEA-3293 gives full details, wiring diagrams and dimensions. *Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

New list prices on single-lamp and Tulamp ballasts for Circline lamps. 60 cycles, 110-125 volts

Lamp Diameter	Lamp Watts	Ballast Cat. No.	Type	Approx Power Factor	OLD List Price Each	NEW List Price Each
12"	32	59G440	Single-lamp rectangular case	50	$2.75	$2.50
12"	32	59G420	Single-lamp circular case	50	3.25	2.50
12"	32	59G425	Single-lamp circular case	90	6.00	4.75
12"–12"	32–32	59G442	Tulamp rectangular case	95	*	6.00
12"–12"	32–32	59G424	Tulamp circular case	95	7.50	6.00
12"– 8¼"	32–22	59G443	Tulamp rectangular case	95	*	6.00
12"– 8¼"	32–22	59G429	Tulamp circular case	95	7.00	6.00
8¼"	22	59G419	Single-lamp rectangular case	50	.90	.90
8¼"	22	59G428	Single-lamp rectangular case	90	3.50	3.50

** These are new designs, not previously listed.*

TWO NEW CIRCLINE BALLASTS, TOO

General Electric announces two new Tulamp ballasts for Circline lamps. Both are of conventional design and will find the greatest use in ceiling fixtures and other general lighting applications. Catalog No. 59G442 operates two 12-inch, 32-watt Circline lamps; Catalog No. 59G443 operates one 8¼-inch, 22-watt lamp and one 12-inch, 32-watt lamp.

GENERAL ELECTRIC

412-12

trolyte, 15 sec is generally sufficient time to give a silver plate about 0.0005 in. thick. Applied voltage should be decreased whenever dark spots appear on the plate, indicating too high a current density. After plating, the part must be immediately cleaned with clear water to remove the excess electrolyte. If the electrolyte paste is too thick and will not flow, it can be thinned with clear water. Since the silver cyanide is poisonous, it should be handled with reasonable care.

To plate knife-switch blades, the $\frac{1}{8}$-in. Micarta covers at each end of the box are removed, disclosing vertical slots that extend part way down the box-end. The box is filled with silver cyanide electrolyte paste, and placed against the open knife-switch blade in such a position that the blade rests in both of the vertical slots. The current is then applied. This process is repeated on each blade of the switch, usually in the area where contact is made with the knife-switch clip.

The plating paddle, shown in Fig 1 (right), is designed to fit into the fuse clips of a 100-amp switch. It is made of $\frac{1}{32}$-in. silver cut to shape from a piece measuring $1\frac{1}{2}$ x $3\frac{1}{2}$ in. and silver soldered to a piece of $\frac{1}{4}$-in. OD copper tubing $4\frac{1}{2}$ in. long. The silver paddle cloth cover is secured with a split Micarta collar. The copper tubing passes through a 1-in. wooden dowel rod handle.

When plating, the paddle is first soaked with clear water and then saturated with silver cyanide electrolyte paste. The fuse clip, in position on the switchboard, is cleaned and filled with electrolyte. The paddle is moved slowly between the fuse clips with about 6 v d-c applied. The paddle is made positive, or the anode, and the clip is made negative, or the cathode. Experience will show how many seconds are needed to plate.

• • •

Rotary with Reversed Fields Operates Poorly

C. A. SCAMMON
Staff Engineer
West Penn Power Co, Pittsburgh, Pa.

REVERSED FIELDS can cause considerable trouble and inconvenience. The following account from the service records of the West Penn Power Co shows how true this is. A new coal mine was connected to the company's lines. The load was a 150-kw motor-generator set. The nearest available source was a rural line on the end of a long, three-phase, 6,900-v line of rather small copper. The only course available was to add a third wire for about two and one-half miles.

The motor-generator set soon began to function improperly. It hunted, blew transformer fuses and caused serious voltage fluctuations.

Since the set was too small for the ultimate load, it was traded for a 300-kw rotary converter which was considered more adequate for the load.

But the d-c voltage on the rotary would not hold up; with only about 300-amp load it would drop from a no-load value of about 325 to about 190. At 400-amp load it became unstable, flashed over and blew a fuse.

Tests were made on both the d-c and a-c sides of the set and both tested perfectly. It was known that the line was small but it had formerly carried more load on the old motor-generator. It appeared as though the only remaining possibility was to build a new and heavier line to the mine.

However, as a matter of routine, the Billing Department discovered that at peak load, the power factor was only about 29 percent.

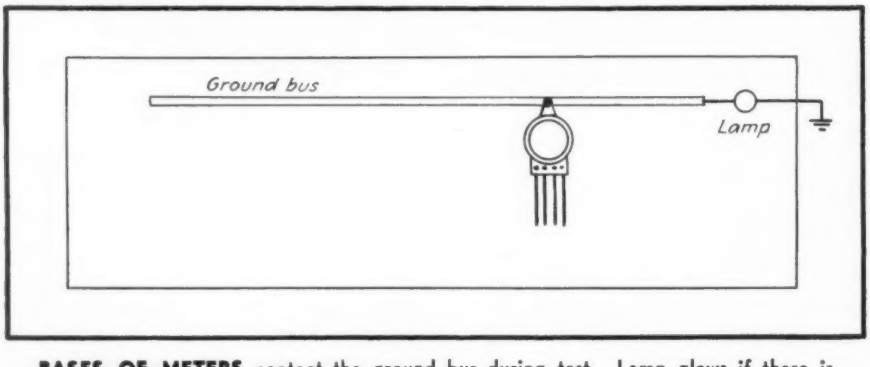
It had been reported that the rotary functioned satisfactorily up to about 400 amp. Beyond this point, difficulties arose. The commutator flashed over and the voltage dropped to virtually nothing.

Since it was known that low power factor meant low field, and since it was also known the shunt field was working, the possibility of a reversed series field was considered.

An automobile storage battery was used to supply a field current and a pocket compass used to check polarity. It was found that both the series and interpole fields were reversed.

After the connections were corrected, the rotary performed in a normal manner.

Detecting Grounded Meter Coils

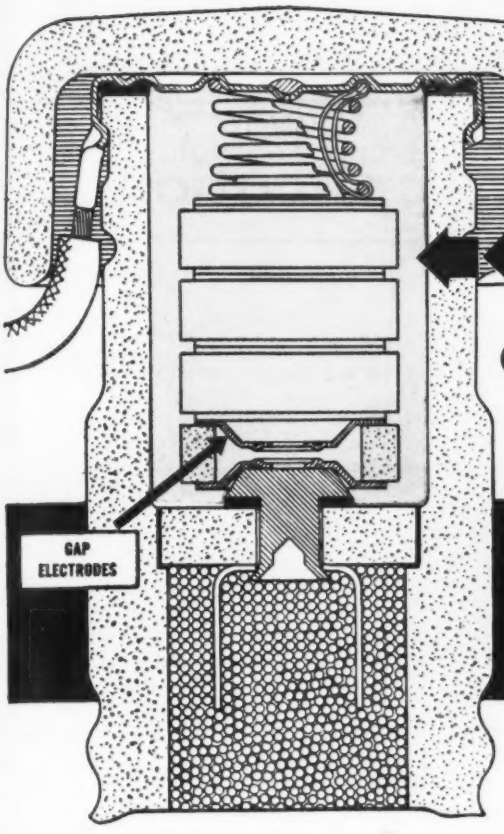


BASES OF METERS contact the ground bus during test. Lamp glows if there is a ground in the meter

E. C. MATTHEWS
Meterman
New Orleans Public Service
New Orleans, La.

ON BOARDS where several meters are mounted for load testing, a simple ground bus arrangement may be used to detect grounded coils or wiring without a separate test. All of the suspension hooks for the meters are connected to ground, in series with a 120-v lamp.

When voltage is applied to a meter for load test, the lamp will glow if there is a ground. This simultaneous check is automatic and so is not overlooked in the test routine. This simple arrangement will save much time.



SEALED-IN NITROGEN assures utmost reliability and service life

The G-E PELLET ARRESTER is the ONLY distribution lightning arrester with gap electrodes permanently sealed in dry, inert atmosphere.

Above: Sectional construction of 9-kv pellet arrester, typical of all ratings, showing separately sealed N_2-filled gap chamber containing series gaps.

Below: Typical standard ratings of pellet arresters; each assuring a new high in performance efficiency and durability on all distribution systems, 15 kv and below.

During manufacture, the separate gap chamber of G-E pellet arresters is completely evacuated of air *and atmospheric moisture*, vacuum-tested for tightness, then filled with dry nitrogen (N_2). This dry, inert gas prevents the formation of any ozone or oxides; keeps the gap electrodes bright as new during years of service operation, and gives more stable gap-sparkover characteristics.

. . . and with unsurpassed protective efficiency.

G-E pellet arresters have *all* these outstanding performance characteristics:

- ★ *Low sparkover voltage to start discharge.*
- ★ *Exceptionally low IR drop, even at high discharge currents.*
- ★ *Large discharge capacity for severe lightning strokes.*
- ★ *Valve action: no exposed live parts or arc flame. Pellet arresters can be used on* any *part of* any *distribution system, rural or urban.*

You pay no more for the BEST. Specify G-E PELLET ARRESTERS—from Bulletin GEA-2975, available at your nearest G-E office, or Apparatus Dept., General Electric Co., Schenectady 5, New York.

GENERAL ELECTRIC

Ground-Fault Neutralizer Application

N. E. DILLOW
Central Station Engineering Division
General Electric Co
Schenectady, N. Y.

Ground-fault neutralizer, also known as a Petersen Coil, which is connected between the system neutral and ground, is essentially an adjustable reactor to "neutralize" ground-fault currents. Application is to any three-phase transmission or distribution system, radial or network, provided that certain criteria are met. These are discussed below.

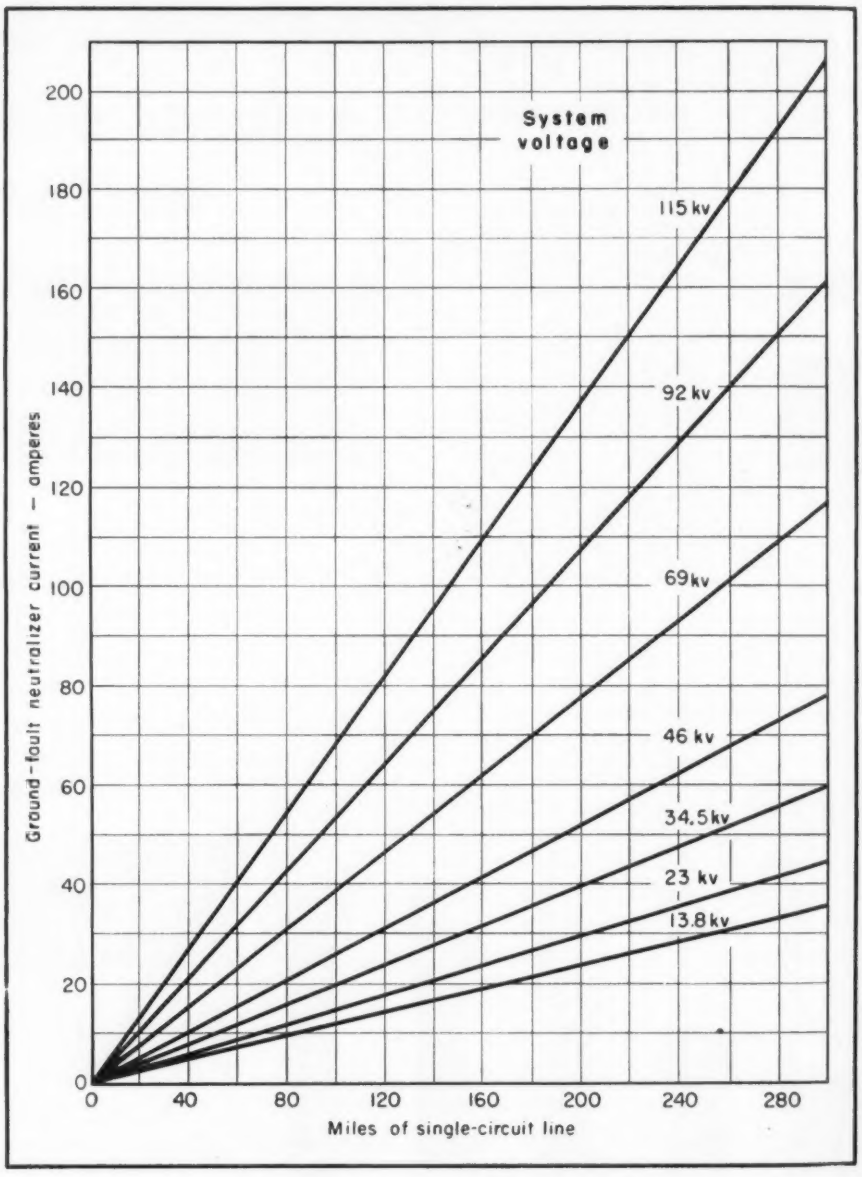
Ratings are as follows:

Voltage rating is same as the system nominal line-to-line voltage.

Frequency rating is necessarily same as the system frequency.

Time rating, whether 10-min or extended, is chosen according to the method employed by the system for isolating permanent ground faults.

Current rating is made equal to or greater than the total system's charging current during a ground fault. The approximate value of charging current can be determined from the graph, as a function of number of miles of single-circuit overhead lines in service.



APPROXIMATE CURRENT RATING a neutralizer should have for protection of single-circuit lines of various lengths and voltages. For double-circuit lines on same tower or poles, particular line sections can be reduced to approximate equivalent single-circuit miles of overhead lines by increasing the mileage by a factor, e.g., 1.3 for 34.5-kv and 1.6 for 69-kv lines. For lines having overhead ground wires, line section can be converted to approximate single-circuit miles by using multiplying factors such as 1.08 for one ground wire and 1.15 for two ground wires

Application Criteria

Number and Location. Theoretically, one neutralizer is sufficient to protect all parts of a metallically connected system. On an extensive system, it is usually advisable to install several small units, preferably at a location from which several lines radiate, so that switching operations will not affect the tuning of the neutralizer appreciably.

The neutralizer imposes an additional load on the transformer to whose neutral it is connected. Where operation may continue for an extended time with sustained ground fault it is necessary that the loading of the transformer be checked.

Where there is no neutral available for connection of a neutralizer, a zig-zag connected grounding transformer is applied.

Balanced Voltages to Ground. The electrostatic balance can be checked in advance of the neutralizer installation by measurement of the voltage between neutral and ground, with the system neutral isolated from ground at all points. If this voltage does not exceed approximately 1 percent of the system line-to-neutral voltage, the balance is reasonable and no steps need to be taken to improve the balance.

Maximum current through the neutralizer with no ground fault on the system is indicative of the proper tap position for tuning the system. This is the usual method employed for tuning the neutralizer in a given application.

System Interconnections. When metallic interconnection with an unprotected system is made, successful operation of a neutralizer is obtained only when the neutralizer is returned to compensate for the added line mileage. In cases where metallic interconnection cannot be made, a two-winding transformer will serve as an isolating barrier as far as neutralizer operation is concerned.

On systems employing autotransformers, ground-fault neutralizers cannot be used unless the rated voltages are within approximately 10 percent of each other.

Cable Systems. The neutralizer can be applied to an all-cable system. In the case of permanent single conductor-to-ground faults, decreased damage to the cable at the fault location will result because of the limiting action of the neutralizer. The system can be operated until the peak load has subsided or until the load can be diverted to other circuits.

BREAKERS

SEALED BUSHINGS

FOR REDUCED MAINTENANCE

Twelve-years' experience with over 80,000 moderate-voltage sealed bushings gave General Electric the background for developing these pressure-tight bushings for high voltages. Complete protection against contamination of the internal insulation structure means maintenance costs are reduced.

- **The initial high dielectric strength of the liquid and solid insulation is maintained by the completely sealed construction which prevents the entrance of air or moisture. Since the expansion chamber is made of metal, the insulating liquid is not exposed to the deteriorating effects of sunlight.**
- **The initial power factor of the bushing is low, and remains low in service, giving assurance that the bushing is in good condition and free from deterioration.**
- **The magnetic liquid-level gage provides an accurate indication of the oil level in the bushing. Even if the glass enclosing the dial is broken there is no danger from leaks or from moisture entering.**
- **When excess potentials, either 60 cycles or impulse, are applied, the bushing will repeatedly flash over externally rather than puncture or shatter.**
- **Bushings in storage are always ready for immediate installation.**

The FK-439 breaker also has a new lightweight interrupter that assures faster circuit interruption. High-speed reclosing is accomplished by the smooth positive action of the pneumatic mechanism. In addition to facilitating maintenance by increasing the accessibility of operating parts, redesign has also decreased the tank dimensions and over-all unit weight. Call or write your G-E sales representative for bulletin GEA-4407 which tells the complete story of the "439" breaker. *Apparatus Department, General Electric Co., Schenectady 5, N. Y.*

Standard 138-kv Completely Sealed Bushing

GENERAL ELECTRIC

859-6

Transmission Line Design Simplified by Graphical Aids . . . II*

Method of design involves the use of three charts. Accompanying second chart has been developed to determine the horizontal separation of conductors in circuits of three voltages. Formulas are given to develop curves for voltages other than indicated

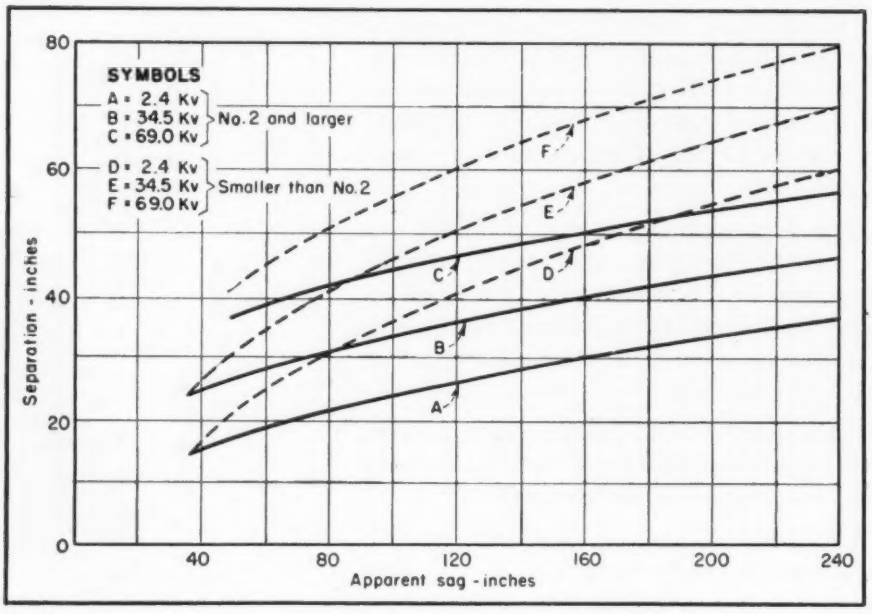


CHART 2 shows required conductor horizontal separation

HAROLD V. WINGFIELD†
Engineer
Sverdrup and Parcel, Consulting Engineers
San Francisco, Calif.

After obtaining from Chart 1 (in preceding issue) the equivalent transverse load due to wind on pole, the second step in this design procedure is to determine the required conductor horizontal separation.

Accompanying Chart 2 is used to determine the separation required for the type of construction contemplated, according to the apparent sag. The phrase "apparent sag" is used as defined in the National Electrical Safety Code and means "The maximum departure of the wire in a given span from the straight line between two points of support of the span, at 60 deg F with no wind loading."

There is indicated in the chart a family of curves applicable to three voltages; namely, 2,400, 34,500 and 69,000. One set of curves may be used for conductor sizes smaller than No. 2 AWG and the other set of curves may be used for conductor sizes No. 2 AWG and larger.

For voltages other than indicated in the chart, points on additional curves may be determined by interpolation or by computations with the use of the following formulas from the NESC handbook:

(A) For conductors smaller than No. 2: Separation in inches $= 0.3$ in. per kv $+ 7\sqrt{\frac{S-8}{3}}$

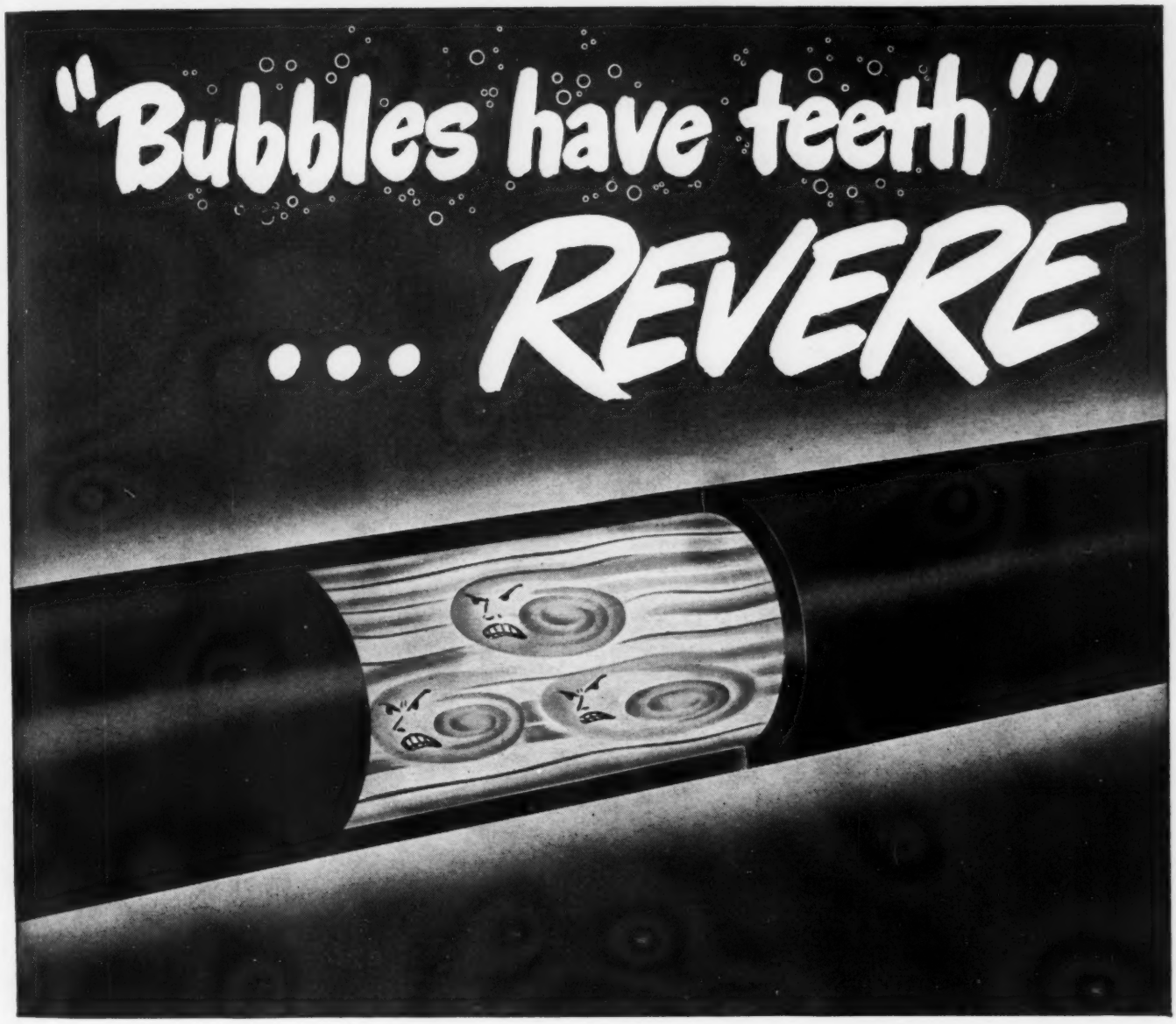
(B) For conductors No. 2 and larger: Separation in inches $= 0.3$ in. per kv $+ 8\sqrt{\frac{S}{12}}$

where S equals apparent sag in inches.

The horizontal separation of the conductors is an important factor in the design of the supporting structure. The maximum separation obtained will provide another point to be considered, which will be noted on Chart 3 in a subsequent issue.

* This series began in ELECTRICAL WORLD, October 11, 1947, page 119.

† Formerly electrical engineer, U. S. Department of Interior, Office of Indian Affairs, Los Angeles, Calif.



SOME years ago Revere said that "Bubbles have teeth." It is still true. Air bubbles in a condenser can eat away at the tubes quite rapidly, and become a cause of failure with consequent re-tubing. Air-entrainment, as it is called, acts in several ways, all destructive to tubes. Air contains oxygen, which directly attacks most metals, forming oxides. Carbon dioxide in solution dissolves these oxides. That is not all. Air bubbles add to the erosion effect of turbulent flow. The higher the velocity, the worse the effect, and the more swift and serious is the combination of erosion and corrosion at points of greatest disturbance. Every effort should be made therefore to keep air from being carried into the cooling water. If you are troubled by frequent re-tubing of your condenser, get in touch with Revere, but first save a few samples from failed tubes for examination by our laboratories to determine the cause of failure. Many users of condenser tubes have found our collaboration exceedingly valuable, and we are always glad to cooperate in an effort to extend tube life.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; New Bedford, Mass.; Rome, N. Y.—Sales Offices in Principal Cities, Distributors Everywhere.

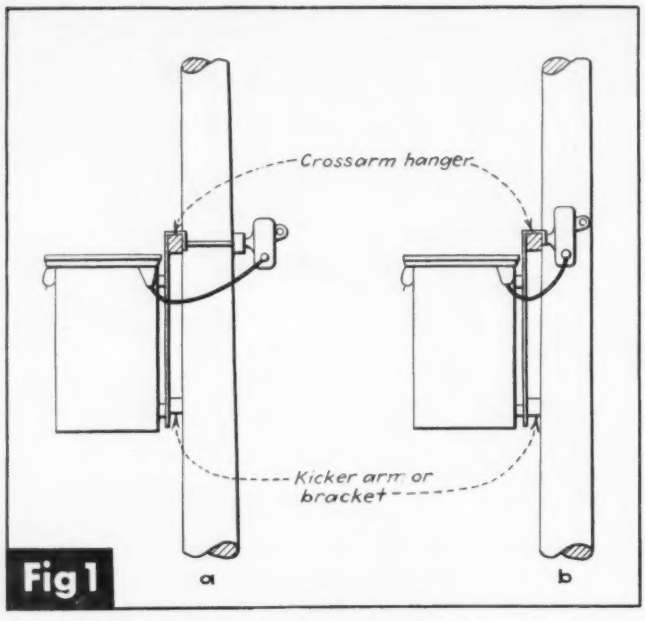


Fig 1

OLDER METHOD OF MOUNTING, with transformer bolted to hanger iron hooked on crossarm, includes variety of kickers and uses two arms (a) in most cases. Single arms (b) are also used

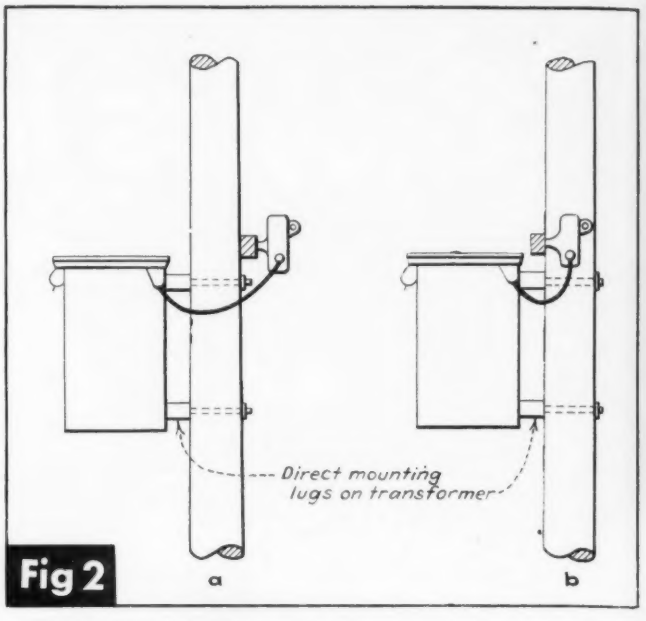


Fig 2

DIRECT-BOLTING TO POLE increases mechanical strength of the mounting. Arrangement on left is most widely used. Hardware for mounting cutouts without arms is also used

An Electrical World Comparison of Practices . . .

Growing Trend Toward Direct-Bolting of Transformers

METHODS of mounting distribution transformers on line poles have in the past included a variety of hanger irons. A gradually developing trend toward direct-mounting arrangements led to adoption, in 1940, of standardized support lugs that could be bolted to the pole. A standard hanger was included in the change, for users who continued with the crossarm mounting.

Adoption of the new mounting lugs and the hanger has been practically universal, but changes in construction practices to provide direct bolting to the pole have been much slower. A survey among 30 companies shows that one-half have drawings or methods for direct bolting. They are purchasing new distribution transformers without the crossarm hangers for at least part of their requirements.

Only five companies have changed completely to the direct-mounting practice, while ten companies continue to use crossarm hangers for some conditions or in some of their districts. See Fig 1.

Six additional companies, now using hangers for all installations, are planning direct mounting as soon as they are able to revise their construction drawings and make the other detail changes. Nine companies indicated no plans are now contemplated for eliminating the hanger and crossarm mounting.

On the approximate basis of company size, this survey indicates that about one-third of new transformers being installed are direct mounted and that this ratio will increase to about two-thirds of the total transformers sold. See Fig 2.

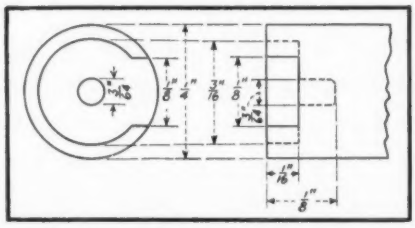
Reasons advanced against mount-

Tool Resets Meter Dial Hands

JOHN BOWLES
Illinois Power Co
Granite City, Ill.

A TOOL to reset meter dial hands to zero can be made from a screwdriver, preferably with a short handle and a ¼-in. diam shaft 1½ in. long. Such a tool is quite useful in a shop where meters are being rebuilt.

The center of the shaft is center punched and a $\frac{3}{64}$-in. hole drilled ⅛ in. deep. Next, a $\frac{3}{16}$-in. bit is used, ground practically flat across the end, but should have just enough pitch to make it follow the center hole already drilled. With the bit a hole is drilled only $\frac{1}{16}$ in. deep. In use this hole fits over the round part of the dial hand. The pinion on which the hand fits sticks up into the small hole. In order to complete the tool a ⅛-in. slot must be cut from the $\frac{3}{16}$-in. hole through the outer wall of the shaft. This fits over the hand pointer.



TOOL to reset dial hands

To reset a dial hand the hole in the end of the tool shaft is put over the round part of the dial hand, with the pointer sticking out the slot. A slight forward pressure is applied as the tool is rotated.

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for any industrial application only *Westinghouse* has all these features

Westinghouse Industrial Fluorescents, long preferred because of their efficiency and performance, now are improved to streamline appearance, make maintenance easier and give greater flexibility in application.

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A Complete Line—28 types, open or closed end, individual or continuous, interchangeable porcelain or baked enamel reflectors. Standard or no blink starters; or instant start ballast.

Easy Installation—All parts accessible, quickly assembled. Easily aligned. Continuous wireway. Five mounting methods.

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Dependable Performance—Co-ordinated engineering in the design of luminaires—starters, ballasts, reflectors, lamps and other accessories—means maximum efficiency and dependable performance.

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BEFORE Poor lighting caused shadows, glare . . . reducing amount and quality of work in this textile factory.

AFTER Increased production . . . higher employee morale with Westinghouse Planned Fluorescent Lighting.

SEE DEMONSTRATIONS OF

LATEST DEVELOPMENTS IN LIGHTING EQUIPMENT at WESTINGHOUSE EXHIBIT

BOOTHS 80-85 • INTERNATIONAL LIGHTING EXPOSITION • HOTEL STEVENS, CHICAGO, NOV. 3-7

ing without hangers usually include reference to the need of some support for fuse cutouts and arresters. Some saving in cost of the hanger iron is not considered sufficient to justify the change unless the arm also can be omitted. However, users of the new hangers feel that the standardization was a good move in eliminating troubles due to many variations in shapes, sizes and mounting hole dimensions.

More positive and secure mounting is the chief reason given for bolting direct to the pole. In most cases one arm is still used to support the protective equipment and to hold the riser wire. Some saving is noted, but the mechanical advantage is considered of primary importance. Rural service-type transformers, on lines without crossarms, have been bolted to the poles. This has helped in the trend for a similar urban practice.

• • •

Faculty for Linemen Training School

AT A RECENT safety conference attended by a number of electric utility engineers, the problem of instruction staff make-up received considerable attention in connection with the training of apprentice linemen. On one large system the discussion of the curriculum was placed in the hands of the standards committee dealing with distribution facilities. The detailed proposals for training were made up by a sub-committee including the distribution superintendents of the companies under the general management of the system, the safety manager of the system and a representation from a state safety council in the central area served. The finally approved program covered two weeks' instruction totaling 60 hours' schooling and field practice.

The teaching staff for the theoretical classroom subjects consisted of two distribution superintendents from different divisions. Both men had a full and complete knowledge of the educational background of the candidates and placed the subject matter on a level where it could be absorbed by them. All lectures pertaining to safety conducted in the classroom were led by a district safety supervisor. He also taught line work in the field in conjunction with two assistant line superintendents who had formerly had long experience as linemen and later as foremen.

This staff did not include any active linemen, for the reason that there are decided differences in the physical characteristics of men, and also because most linemen learned their business in the "old school" method. From this old school background it was felt that many active linemen had acquired habits or methods, which, while satisfactory for them and probably "safe" as well, were not assuredly of good influence on any aspiring group of potential new linemen of varied physical types and not exactly limited to one common degree of aptitude. From the safety angle it seemed desirable to have a common standard for safe climbing in which applicants would be shown a certain method of climbing that would be as safe as possible for all physical types.

As a result, the instruction in climbing was given without the use of climbing demonstrators (the positions on the pole would otherwise have varied widely with the physical set-ups of the individuals concerned). A sound moving picture film was shown and stub pole climbing tests followed. Methods were again compared by later showings of the film. The new men after training entered line crews without the inferiority complex so apt to develop if they had to demonstrate their awkwardness in reaching a working position before an audience of skilled climbers in the crew.

This staff set-up, combined with the visual aids and gradually increasing heights of stub pole work during the instruction period, proved successful in providing a solid foundation for field work.

• • •

Use of Damper Windings on A-C Generators

V*—OSCILLATION

WILLIAM L. RINGLAND
Electrical Engineer
Allis-Chalmers Mfg Co
Milwaukee, Wis.

DAMPER WINDINGS do, of course, perform the well recognized function for which they were named in damping those types of oscillation which are not the result of a periodic impressed force.

The transient oscillation of a generator at its natural frequency following a sudden change in operating conditions is often observed, and the effect of dampers in hastening the decay of these oscillations is well known. For a typical case in question, a damper winding might reduce the time constant for this decay from a value of 4 sec without dampers to perhaps 1 sec.

Sustained Oscillation

Resistance in the armature circuit can result in a sustained oscillation, the amount of resistance required being less at lighter loads. The condition causing this oscillation is frequently called negative damping. Positive damping added by a damper winding greatly increases the amount of armature circuit resistance which can be introduced without resulting in oscillation.

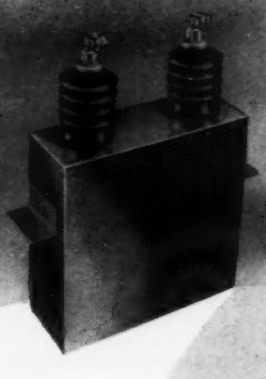
Faulty governor operation can cause oscillation regardless of the generator characteristics, although in some instances generator damping may ameliorate conditions resulting from the governor. However, difficulty of this nature should and can be corrected at its source, and should

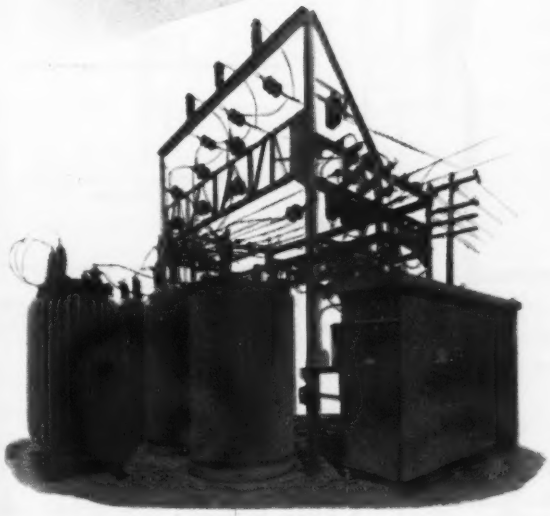
* This series began in ELECTRICAL WORLD, August 16, 1947, page 81.

First Choice / **Proven in the Field . . . Not for 1 year but for 10 years!**

CORNELL-DUBILIER

CAPACITORS





Dependability is the No. 1 reason why Cornell-Dubilier Capacitors are the first choice of power engineers. Proof of this dependability is yours in the service records of more than 3,000 utility installations. These field-test records for over ten years offer conclusive evidence of extraordinary trouble-free performance under punishing extremes of climate and operating conditions. C-D's can meet your system's specific requirements with greater value per dollar invested than any other capacitor. Write to Cornell-Dubilier Electric Corporation, Dept. D10, South Plainfield, New Jersey. Other plants in New Bedford, Worcester and Brookline, Mass., and Providence, R. I.

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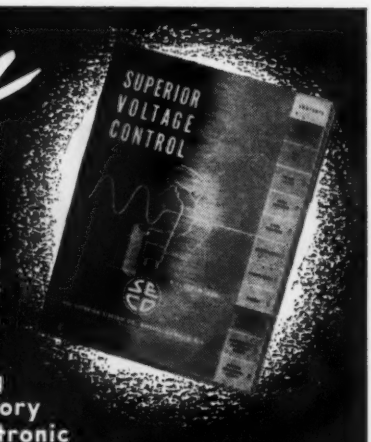
CORNELL-DUBILIER • **WORLD'S LARGEST MANUFACTURER OF CAPACITORS**

New Bulletin 547



Features all the engineering data required for selection of the correct voltage control apparatus.
FOR INSTANCE . . .
If you have a requirement involving variable voltage testing or laboratory control of heat . . . light . . . electronic equipment—refer to the Superior bulletin, page 7.

VOLTBOX A-C POWER SUPPLIES

U-1000

Two models of VOLTBOX a-c power supplies are available . . . the unregulated and regulated models. For testing from a stable single phase power source, an unregulated VOLTBOX is generally employed. This type consists of a POWERSTAT variable transformer; large easily read voltmeter; combination quick-trip magnetic circuit-breaker and "on-off" switch; pilot light; output receptacles and binding posts; and six foot cord-plug. Four types of unregulated VOLTBOXES for 115 or 230 volt service in 1 and 2 KVA ratings are offered.

The regulated VOLTBOX is recommended when the incoming line voltage fluctuates — preventing accurate readings. This unit is similar to the unregulated models except a transformer type stabilizer is included to maintain constant voltage to the variable transformer in the VOLTBOX.

To get your copy of BULLETIN 547 . . . and for more information on VOLTBOX a-c power supplies, write

SUPERIOR ELECTRIC, 1103 Laurel Street, BRISTOL, CONN.

THE SUPERIOR ELECTRIC CO.
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Powerstat Variable Transformers • Voltbox A C Power Supply • Stabiline Voltage Regulators.

not constitute a valid argument in favor of generator damper windings generally.

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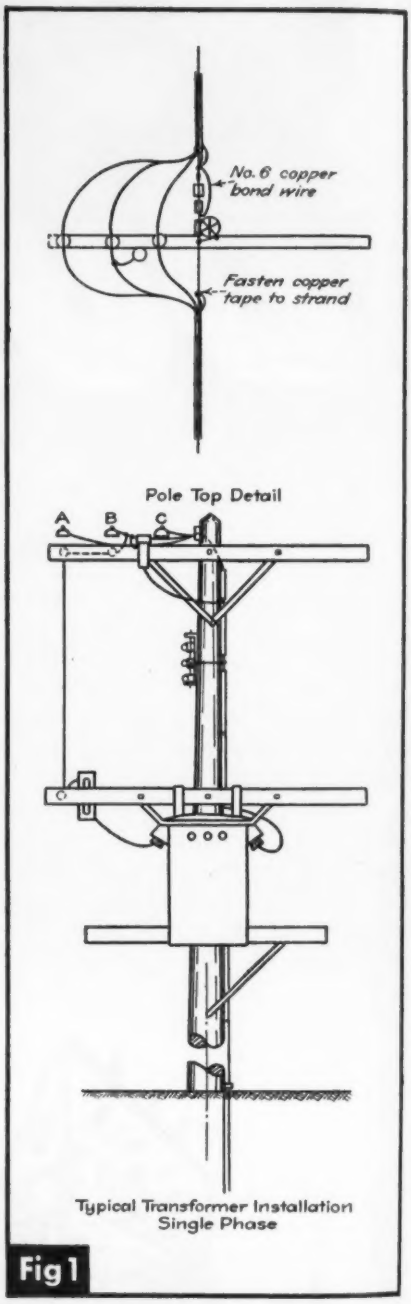
Details for Aerial Cable Installation

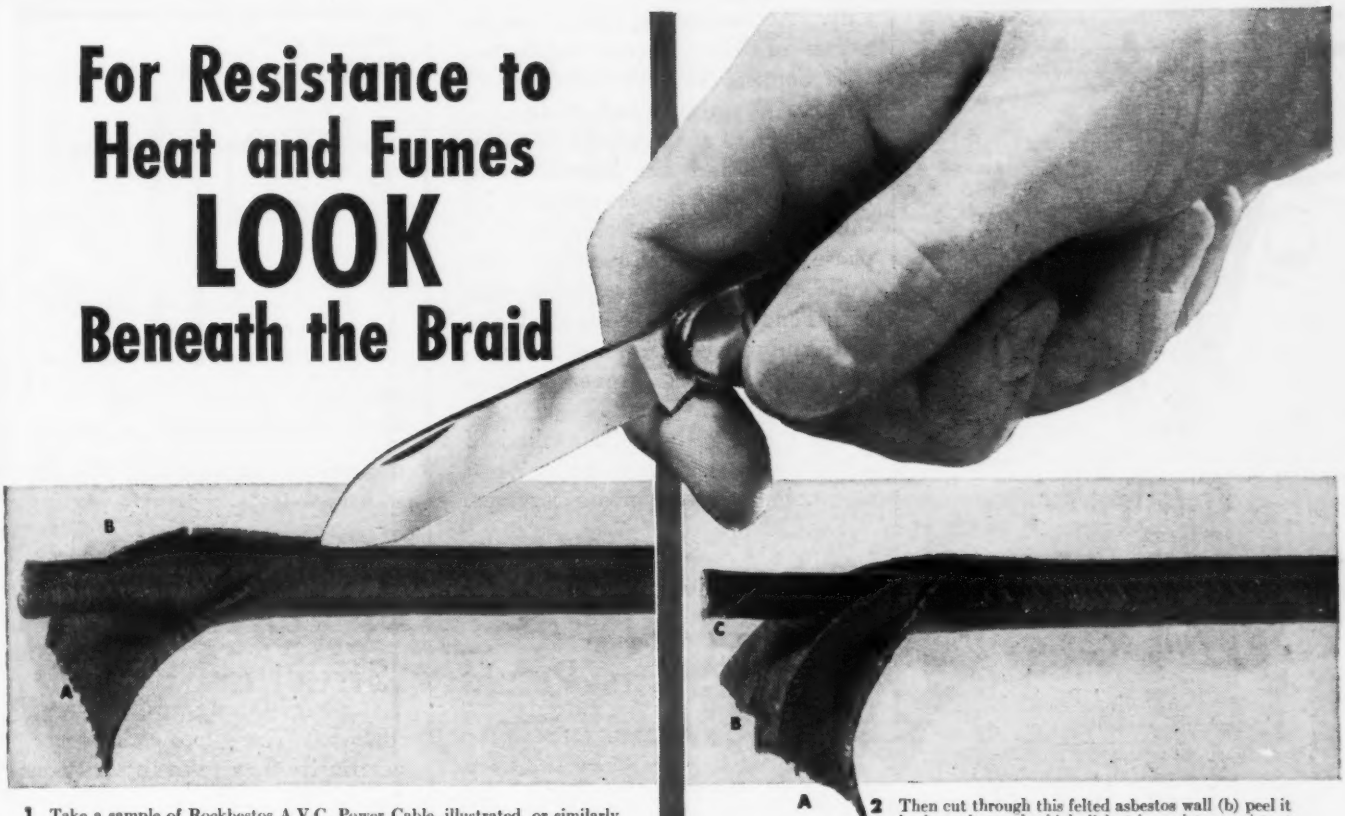


POLE TOP DETAIL and typical transformer installation show method of fanning out cable

FRED P. GILPIN
Electric Distribution Dept
Kansas City Power & Light Co
Kansas City, Mo.

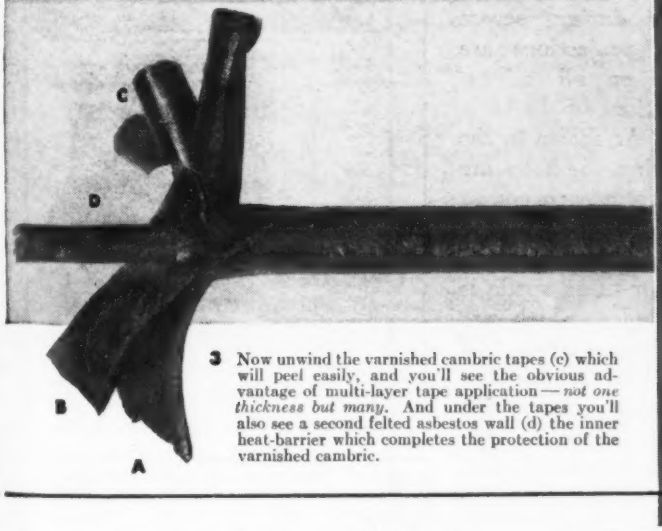
THREE insulated conductors cabled and supported by messenger on poles have been placed in service as an initial step in aerial cable distribution in a residential district of Kansas

For Resistance to Heat and Fumes LOOK Beneath the Braid

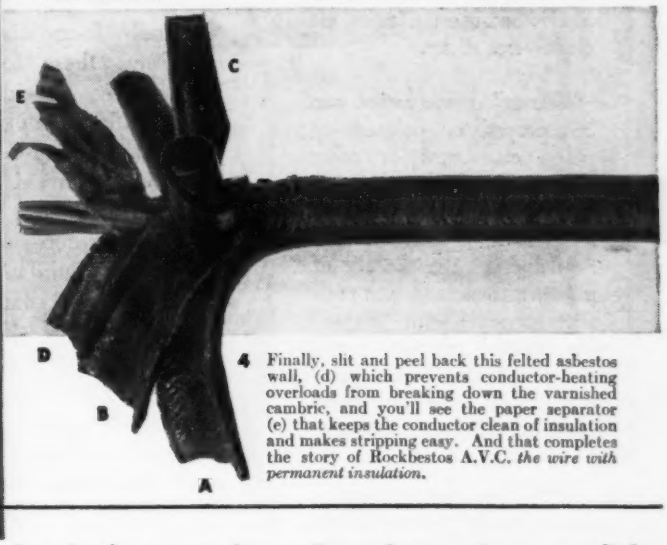


1 Take a sample of Rockbestos A.V.C. Power Cable, illustrated, or similarly insulated Motor Lead Cable, slit open the heavy asbestos braid (a) which is resistant to heat, flame, moisture, oil, and grease, and you'll find beneath a firewall of felted asbestos (b) a permanent heat-barrier against high ambient temperatures.

2 Then cut through this felted asbestos wall (b) peel it back, and see the high-dielectric moisture-resistant varnished cambric tape (c) it protects from heat, flame and oxidation. Notice, too, the uniform coverage of the tapes, helically applied like the felted asbestos to assure perfect and permanent centering of the conductor in the insulation.



3 Now unwind the varnished cambric tapes (c) which will peel easily, and you'll see the obvious advantage of multi-layer tape application — *not one thickness but many.* And under the tapes you'll also see a second felted asbestos wall (d) the inner heat-barrier which completes the protection of the varnished cambric.



4 Finally, slit and peel back this felted asbestos wall, (d) which prevents conductor-heating overloads from breaking down the varnished cambric, and you'll see the paper separator (e) that keeps the conductor clean of insulation and makes stripping easy. And that completes the story of Rockbestos A.V.C. *the wire with permanent insulation.*

A casual inspection isn't enough when it comes to selecting wire and cable for performance in hot-spot service. You've got to look *beneath* the braid! When circuits must operate next to boilers, furnaces, steam lines, drying ovens, resistor grids and soaking pits it is vitally important that the wire is *completely* insulated to withstand heat and moisture, corrosive fumes, oil, grease and flame.

The photos and text above tell the "inside story" of the reasons why Rockbestos A.V.C. Power, Motor Lead and Lighting Wires and Cables (National Electrical Code, Type AVA) will protect circuits and reduce maintenance . . . why their *permanent insulation* makes possible *continuous operation* at 230° F., under varied severe conditions without baking brittle, flowing or rotting.

Send for a sample, look beneath the braid, and see for yourself why Rockbestos A.V.C. gives more service per foot in the worst places. Several types for power, lighting and control circuits, switchboards and equipment, in 600 to 5,000 volt ratings. Just ask for what you are interested in. Write to:

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ROCKBESTOS A.V.C.

The Wire with Permanent Insulation

125 different permanently insulated wires, cables and cords

developed by Rockbestos for various severe operating conditions

NEW YORK BUFFALO CLEVELAND DETROIT
PITTSBURGH ST. LOUIS LOS ANGELES OAKLAND, CALIF.

Protection for POLES AND CROSS-ARMS — old or new

Chapman "Penta" Preservative is rapidly winning acceptance as the preferred material for pressure-treatment of wood which is to be exposed to moisture and insects. Tests prove its superior qualities. Linemen and other workers like it because the poles are clean—not sticky.

"Penta" Preservative can be sprayed or painted on poles, cross-arms or other timber already in place, or treatment can be by soaking if pressure equipment isn't available. In the absence of pressure treatment, non-pressure methods with "Penta" Preservative are very useful either for new stock, poles and timber in service, or reclaimed poles and cross-arms.

We'll be glad to supply details and facts about Chapman "Penta" Preservative for protecting old or new poles and other timber. Write us today.

CHAPMAN

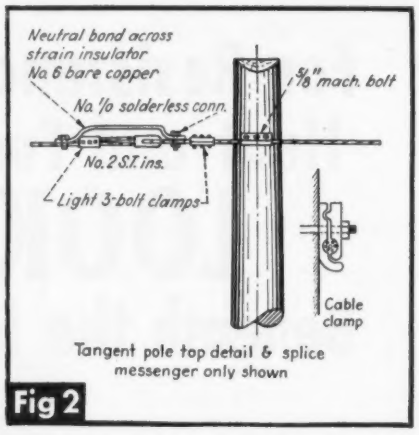
CHAPMAN CHEMICAL COMPANY
Suite 542
333 North Michigan Ave., Chicago 1, Ill.

"Penta" Preservative contains *Pentachlorphenol*, a product of *The Dow Chemical Company*.

City. Accompanying details are for a line of No. 6 copper conductors with Copperweld EHS messenger (7 No. 10, 30 percent conductivity).

Conductors are insulated for 5 kv, unshielded, and are bound to the messenger with copper ribbon. Insulation of each conductor carries a phase identification marker. The cable assembly is spread out with each conductor on crossarm pins at poles and provision is made for present or future transformer installations.

Fig 1 and 2 show the method of supporting messenger and the details of fanning out conductors for taps.


Neutral bond across strain insulator
No. 6 bare copper
No. 1/0 solderless conn.
No. 2 S.T. ins.
Light 3-bolt clamps
5/8" mach. bolt
Cable clamp
Tangent pole top detail & splice messenger only shown
Fig 2

SUPPORTING METHODS for messenger and splicing arrangements

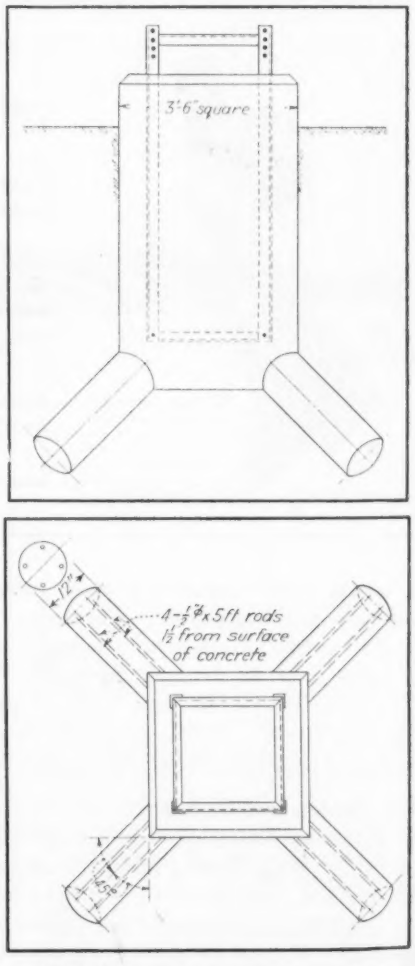
• • •

Projections Prevent Structure Uplift

FRANK C. BROGAN
Electrical Engineer
Ohio Public Service Co
Elyria, Ohio

LABELED "tornado toes" and designed to prevent uplift of conventional foundations during severe storms, these four projections are regularly provided on all substation column foundations of the Ohio Public Service Co. As shown in the accompanying drawing, the holes are bored at an angle from each corner of the square excavation for the standard foundation.

An anchor drill or tiling spade is used to bore the holes, which are 12-in. diameter and are carried 3 ft into undisturbed earth beyond the main excavation. Four ½-in. by 5-ft reinforcing rods are used in each of the holes, which are filled with concrete as a part of the complete foundation. These projections are less expensive than an equivalent area of square base added to the excavation and foundation.



HOLES bored 3 ft deep beyond the corners of usual footing excavation provide extra bearing and prevent uplift of conventional column foundation

Correction In Formula

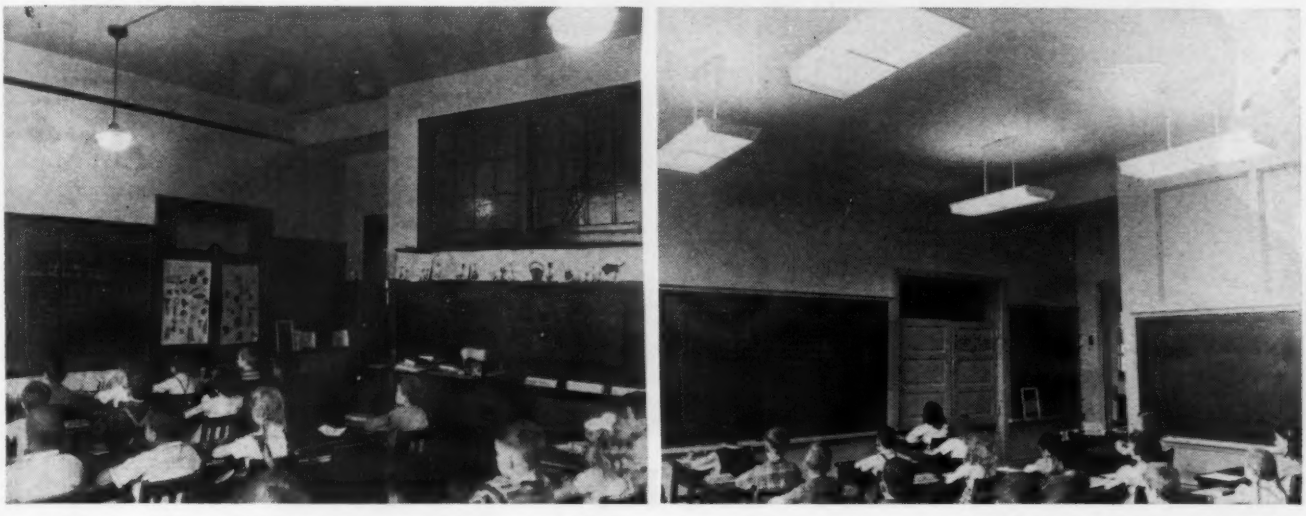
OUR ATTENTION has been called to an error that appeared in the article "Voltage Drop Charts for Selecting Insulated Aluminum Cable" on page 114 of the September 13 issue of ELECTRICAL WORLD. The error appears in formula (2) for V_s — Sending volts to neutral.

The correct complete formula is:

$$(2)\ V_s = \sqrt{(V_1 \cos\theta + RI)^2 + (V_1 \sin\theta + XI)^2}.$$

LOAD BUILDING

Modernization Plan for Rural and Small-Town Schools



STRIKING COMPARISON between the inadequate, old-style illumination of a typical small-town school room (left) and the redecorated, relighted room (right). Installation of additional tackboard resulted in increased high-reflecting surfaces

ROBERT G. CASS
Lighting Engineer
New Jersey Power & Light Co, Dover, N. J.

IT IS FREQUENTLY a question as to how far utility lighting engineers should go in handling school lighting problems. The school modernization plan of the New Jersey Power & Light Co has met with enthusiastic response from the Lambertville, N. J., school authorities. This plan of lighting recommendations includes suggestions for repainting, rearrangement of seating, or other minor alterations that may be desirable. The plan is particularly fruitful in dealing with rural and small community schools. Many of these are as much as 50 years old and improvement funds are usually limited.

In Lambertville, two adjoining classrooms in one school were selected to serve as examples. In each of these rooms were two incandescent fixtures. Illumination was from 8 to 12 ft-c near the windows to 2 to 5 at the inside wall. The wall, between the two rooms, contained several blackboard panels that could be raised partially to convert the two rooms into one. This feature had been unused for many years. Wood trim was dark.

The power company recommended that six 4-lamp shielded fluorescent fixtures be installed in each room; blackboards be rearranged; considerable areas of tackboard be installed; and the rooms redecorated in lighter colors. The difference when these changes were made appears in the accompanying pictures.

The redecoration and the installation of additional tackboard resulted in a considerable increase in reflecting surface. This was of great value in the higher level of foot-candles resulting from the installation. After the room was completed and had been in service approximately 80 hr, footcandle readings were retaken. These readings ran from 40 ft-c at the inside wall to 60-80 ft-c on the desks adjacent to the windows.

• • •

Electric Cooking Cuts Hotel Operating Costs

ELECTRIC COOKING saves the Read House in Chattanooga, Tenn., nearly $240 a month, according to *Restaurant Management*, August, 1947. The hotel serves a monthly average of 80,000 meals. This production taxed the previous cooking facilities to the limit. The management was faced with the alternatives of restricting patronage or improving cooking conditions. Kitchen heat, entering the dining room and lobby, added load to the air-conditioning system.

The change to electric cooking was made last January. It took only two weeks to remove the old equipment and install the new. In the main kitchen and a smaller one for the "Snack Bar" are four heavy-duty ranges, a large bake oven, three broilers, four fry kettles, two griddles and other small equipment. Cost was $7,170, including $862 for installation.

The savings result from the elimination of both a $350 average

Investigate...

THE FISHER-PIERCE PHOTOELECTRIC CONTROL FOR MULTIPLE STREET LIGHTS

NEW LIGHT ON THE PROBLEM OF STREET LIGHTING

The Fisher-Pierce Company — specialists in electronic applications — offer a new control — a simplified Automatic Photoelectric Unit for Multiple Street Light Control.

The interest already shown by hundreds of utilities in such a development centers around these features:—

1. **Flexibility** — individual street lights can be connected directly to 117-volt distribution lines.
2. **Lower Costs** in service and maintenance compared with other methods of control.
3. **Quality** of lighting service secured.

With FISHER-PIERCE PHOTOELECTRIC CONTROL it is possible to preset the value of illumination at which it is desired to turn on the lights— lights so controlled will go on at that value of illumination day after day regardless of specific location, weather conditions, or obstacles.

Technical Characteristics & Features — This control operates dependably down to less than 1 foot-candle. It has a built-in differential and time delay to avoid operation by lightning, clouds or cycling— absolute minimum of components.

Maintenance Procedure — Routine maintenance necessary only once per year— In addition to its technical advantages, plug-in replacement eliminates the need for service on the pole and permits full utilization of skilled technician's time.

Installation— Heavy galvanized mounting bracket fastens directly to distribution pole.

This low cost control has received wide acceptance by farsighted lighting engineers. Over 2,000 controls have been under field test by 250 utilities for periods up to two years throughout this country and abroad.

Write for Bulletin FP61300 for further information.

Units can be shipped from stock.

FISHER-PIERCE COMPANY

82 CEYLON ST., BOSTON 21, MASS.

monthly fuel bill and an estimated $110 meat shrinkage loss.

•

Estimated Billings Circumvent Meter Shortage

Table for Estimating Kwhr Consumption

		Number in Family			
		2	3	4	5 or more
House or Apartment up to 5 Rooms Inclusive	A	25	30	30	40
House or Apartment from 6 to 7 Rooms Inclusive	B	30	35	40	45
House from 8 Rooms up	C	40	40	45	55
Range		75	90	100	120
Refrigerator 5 years old or less		35	35	35	35
Refrigerator older than 5 years		45	45	45	45
Home Freezer		45	45	45	45
Gas Heating, gravity air, steam or hot water		3	3	3	3
Gas Heating, forced air	A	20	20	20	25
	B	30	30	30	30
	C	35	35	35	35
Oil Burner, gravity air, steam or hot water		10	10	10	10
Oil Burner, forced air	A	30	30	30	30
	B	35	35	35	40
	C	40	40	45	45
Stoker, gravity air, steam or hot water		10	10	10	15
Stoker, forced air	A	25	25	30	30
	B	35	35	40	40
	C	40	40	45	45
Washing Machine		3	3	4	4
Automatic Washing Machine		5	5	5	5
Ironer		10	10	15	15
*Hand Iron		5	5	10	10
Toaster		4	4	4	4
**Electric Roaster		8	10	10	15
Radio		15	15	15	15
**Coffee Maker		7	7	7	7

*Disregard if Customer owns an Ironer
**Disregard if Customer owns an Electric Range

THE Iowa Electric Light & Power Co has developed a check list for calculating flat monthly rates. This method of billing is used because there are not enough meters available to take care of new connections. However, this unmetered service is confined to the city of Cedar Rapids. All available meters are diverted to small towns and rural services.

The accompanying table, compiled by Earle G. Nichols, Cedar Rapids district manager, shows the check list of estimated kilowatthour consumption. The basic figure of kwhr for size of residence and number in family is added to the energy consumption of the appliances and devices in use in the particular case. For instance, a family of four persons

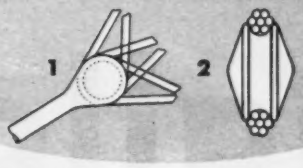
Build LINE SECURITY *with* CHANCE ANCHORS
...the *EXPANDING ANCHOR* Digs In and Holds!

Chance All Steel Expanding Anchors are specified by engineers who know the value of equal distribution of holding power.

Built of tough, heavy ribbed steel, they *dig in* to solid earth with a minimum of soil disturbance and *hold* without danger of creeping or pulling out. The powerful blades expand in opposite directions, equalizing strain. Grooved guideways eliminate side twisting. For 21 years Chance Steel Expanding Anchors have been on the job, giving complete satisfaction. You can be sure of dependable results from these proven anchors. Once they're in—they're in to stay!

Improved Thimbleye FORGED STEEL ROD

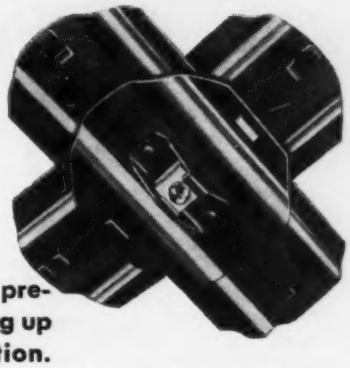
This high strength, drop forged steel rod features the improved Chance Thimbleye.



1. **Full rounded eye protects strand at varied angles, aids slack pulling.**
2. **Groove fits snugly around strand and prevents flattening or spreading.**

CLOSED POSITION

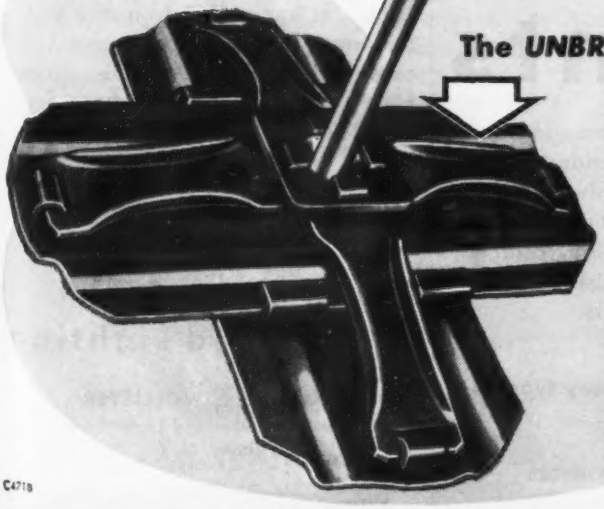
EXPANDED POSITION



DESTRUCTIBLE NUT RETAINER...

The patented nut retainer prevents the anchor from riding up the rod during installation. Permits driving the rod through the anchor into the ground when abandoning the anchor, and also acts as a truss brace.

The *UNBREAKABLE* ALL STEEL ANCHOR



Chance Expanding Anchors are built to "take it" both in handling and in the ground. The new expanding arm (arrow) is 60% stronger—will not buckle—assures full expansion of blades.

How much will an anchor HOLD?

Chance engineers have developed a new formula for determining the type and kind of anchor to use for every guying condition. Your copy is ready and will be sent upon request.

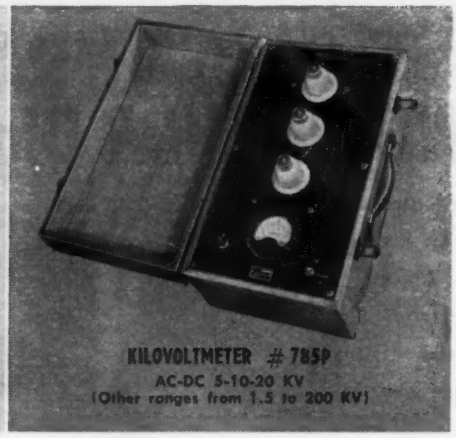
C471B

A·B·CHANCE CO·

CENTRALIA, MISSOURI · SAN FRANCISCO, CALIFORNIA

abc INDUSTRIES

LOW-RESISTANCE TEST SET #670C
1,000 to 500,000 micro-ohms
(Other ranges from 200 micro-ohms to 100 ohms)



KILOVOLTMETER #785P
AC-DC 5-10-20 KV
(Other ranges from 1.5 to 200 KV)

Shallcross

KELVIN-WHEATSTONE BRIDGE #638-2
0.0001 ohm to 11.11 megohms
(7 additional designs and 15 types of percent limit bridges)

DECADE BOX #825
11,110 ohms in 1 ohm steps
(Other designs, 1 to 7 dials, from 0.1 to 11,111,110 ohms)

. . . for electrical measurements

VOLTAGE DIVIDER (Decade Potentiometer)
10,000 ohms total. Voltage ratio: 0.001 to 1.0
(Other 3- and 4-dial designs, 1,000 to 100,000 ohms)

Shallcross Electrical Measuring Instruments are made in many types — from sturdy, inexpensive bridges for school and production use, to fault location bridges, high-voltage test equipment, low-resistance test sets and numerous others.

Write for Bulletin on any type.

AKRA-OHM PRECISION RESISTORS
14 Standard Types.
50 available special designs.

PRECISION SWITCHES
350 designs for instruments and high-grade electrical apparatus.

ATTENUATORS & CONTROLS FOR COMMUNICATION EQUIPMENT

Shallcross Manufacturing Co.
Electrical Measurement Specialists
Dept. EW-107 Collingdale, Pa.

in a six-room home with range, refrigerator, forced-air oil burner, washing machine, hand iron, toaster, and radio, would have an estimated consumption of 239 kwhr per month.

When an application is received for a new service in the city area, the customer fills out a simple form. This gives the necessary data for estimating. He signs an agreement to pay a flat monthly charge based on the estimated consumption. The agreement states that an adjustment will be made if indicated by readings of a meter subsequently installed.

As yet no meters have been installed to replace flat-rate service. Thus, no check is available of estimates against metered consumption. It is felt, however, that the estimates are quite accurate and adjustments will be few. In no case has any applicant for service objected to the method. It appears to be working out very well.

The billing department has had some opportunity to check the accuracy of the estimating table by using it in high bill complaints. The complaining customer is asked to make out a statement of his uses of service. His bill is then calculated according to the table. In most cases, the estimated bill comes within a few pennies of the metered billing.

In the first three-month period of the new policy, 150 unmetered services have been connected. Among these, there has been a considerable range in the estimated bill agreed upon. It has varied from the $1.00 minimum to $10.00 per month. In cases where estimated bills exceed $10.00 per month, meters have been installed.

•

Color Views Sell Planned Lighting

COBURN D. HOLLISTER
New York Power and Light Corp
Albany, N. Y.

PHOTOGRAPHS of planned lighting installations are commonly used to show prospects how their places will look when lighted the modern way. To enable its customers to see even more clearly the types of lighting recommended, the New York Power and Light Corp uses a slide viewer and

A NEW CONCEPT IN TROFFER LIGHTING *by* MITCHELL

The new MITCHELL Fluorescent Troffer marks a signal advance in attractive, economical, high-intensity lighting for every commercial application. Unsurpassed for clean-lined, simplified design, the MITCHELL Troffer offers exclusive advantages for flexible adaptability to *any* type of ceiling. Available in a choice of three systems: Open type, Glass Shielded, or Louvre Shielded. Designed and built to the most exacting standards of quality . . . pledged to deliver maximum effective illumination with a minimum of service requirements. Acclaimed by wholesalers, contractors, utilities, architects and users as the last word in *modern* Fluorescent Troffer design!

The new MITCHELL Troffer System features ingenious design of the utmost simplicity and flexibility. It consists of:

1. *The "Basic Unit"*—(reflector and wireway channel wired with ballast and starters) for 2-40 watt lamps, for 3-40 watt lamps, and for INSTANT START.
2. *Hinged Glass Frame*—of ribbed, prismatic glass to provide glass shielding.
3. *Hinged Metal Louvre Frame*—for completely louvred illumination.
4. *End Plate* for ends of continuous rows, and *Coupling Plate* to connect units together in rows.

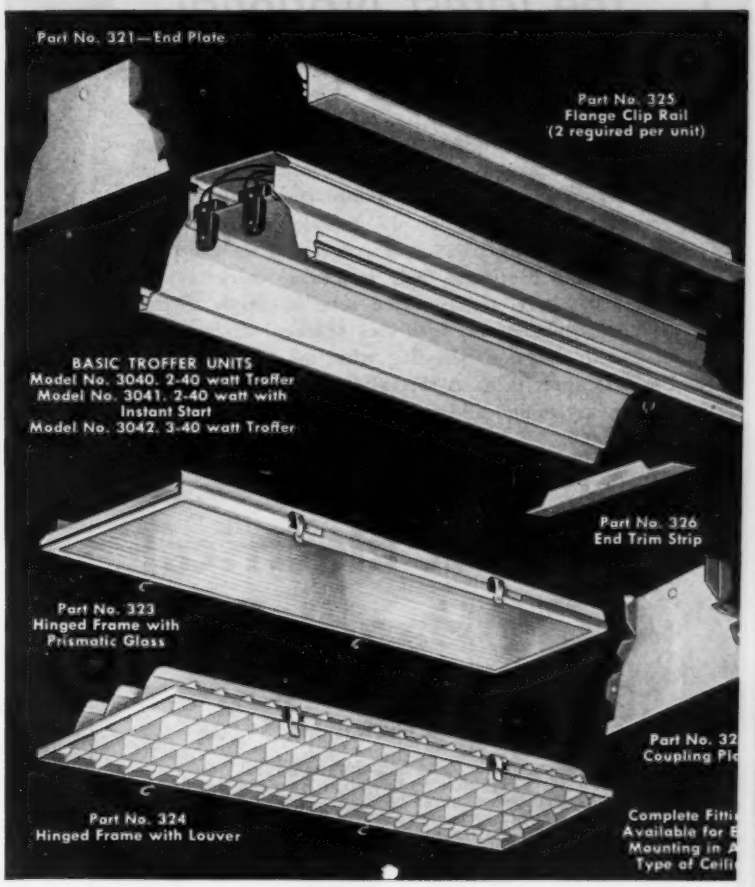
For ceilings of Tee-Bar snap-in block construction, the "Basic Unit" *snaps right into place*—requires no accessory fittings. For other types of ceilings—plaster lath, acoustical tile, etc.,—a minimum of simplified fittings are provided to assure easy, accurate, permanent mounting.

WRITE FOR FULL DETAILS. Electrical Wholesalers, Contractors, Utilities and Architects are invited to write for the MITCHELL Troffer brochure, packed with detailed descriptive and technical data covering America's most wanted Fluorescent Troffer System.

MITCHELL

Mitchell Manufacturing Company
2525 CLYBOURN AVENUE, CHICAGO 14, ILLINOIS
In Canada: Mitchell Manufacturing Company, Ltd., Toronto, Canada
Far West: *Complete Modern Plant and Sales Office at Los Angeles*
Serves the Entire Pacific Coast Area
1019 NORTH MADISON AVENUE, LOS ANGELES 27, CALIFORNIA

These Simple MITCHELL Components Make a Perfect Troffer System for Every Recessed Lighting Need


Part No. 321—End Plate
Part No. 325
Flange Clip Rail
(2 required per unit)
BASIC TROFFER UNITS
Model No. 3040. 2-40 watt Troffer
Model No. 3041. 2-40 watt with Instant Start
Model No. 3042. 3-40 watt Troffer
Part No. 326
End Trim Strip
Part No. 323
Hinged Frame with Prismatic Glass
Part No. 324
Hinged Frame with Louver

Exclusive MITCHELL *Features*

Here are just a few of the remarkable new features that distinguish the MITCHELL Fluorescent Troffer:

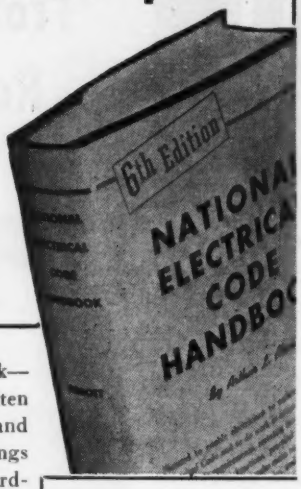
Exclusive "Swing Hinge" Frame. Provided on Glass Frame and Louvred Frame. Special Hinge Hooks permit frame to swing down freely—for easy relamping or cleaning. Frame snaps shut tightly with two spring latches. Press the latches and the frame swings down.

Jack Chain Suspension. For easy wiring access. Two jack chains with "S" hooks at either end suspend reflector from channel. Permits wiring without necessity of holding reflector or ballast. When wiring is completed, reflector is connected to channel by simply tightening nuts provided. Truly a time-saving one-man installation feature.

End Plate and Coupling Plate Feature. End plates for use at ends of a continuous row of units, and coupling plates for connecting two units together, have "threaded bushing" holes. A screw pushed in from the inside of the reflector engages the bushing and is tightened. No nut is required.

How to handle all kinds of wiring and installation jobs

in strict compliance with the latest National Electrical Code



Here is the long-awaited electrical contractor's job-book—the first revision in six years—almost completely re-written in accordance with the new 1946 Code requirements and planned to enable electricians to understand the new rulings of the National Electrical Code and to do work in accordance with it. It restates involved rules in simple language; it provides explanations, furnishes practical directions, and is filled with diagrams showing what the Code rules mean and how to apply them. A special arrangement groups rules, making it easy to find all the rules applying to any given job.

Just Out—6th Edition

National Electrical Code Handbook

By Arthur L. Abbott

633 Pages, 418 illustrations, $4.00

This handbook is one of the most unusual and helpful electrical books published. It gives a wealth of information from the practical angle of getting jobs done according to code requirements. It saves delay in starting jobs, it saves time and money in avoiding false starts, errors and violations. At the same time, it contains so much clearly presented information that it will pay you to use it for general reference on many questions of material, plans, wiring, and installation.

Based on the 1946 National Electrical Code *adopted as the 1947 Code*

Covers all the new Code revisions, showing you:

—how to reduce wiring costs for ranges

—how to protect motors against mechanical injury

—how to install infra-red lamps

—how to install capacitors for power-factor correction

—how to protect transformers against overcurrent

—how to wire rigid conduit for voltage not exceeding 15,000

—how to form "stress cones" at cable terminations, etc.

Read this partial list of contents:

approved types of wiring
installation requirements applying to all types of wiring
cable assemblies
raceways—requirements applying to all raceways
underplaster extensions
outlet, switch and junction boxes
switches — panelboards — switchboards
electrical appliances
motors—motor controllers
motor wiring and protection
generators—transformers—autotransformers
capacitors—resistors and reactors—lightning arrestors — storage batteries
grounding
overcurrent protection
design of wiring installations—branch circuits—feeders and services
outside wiring
remote-control—signal and low-energy power systems
elevators—cranes and hoists
construction of materials

All rules for a job grouped in one place

Once you have looked up a rule in this handbook, you may rest assured that you will not find later that there was another rule to be considered and that the job will have to be done over. It reduces a maze of scattered rules to a logical and understandable system.

It explains how the Code applies to:

- commercial buildings
- homes
- factories
- theaters
- hazardous locations
- signal systems
- high-voltage equipment
- television equipment
- motor installation
- design of installations

See this helpful book 10 days *FREE*

JUST MAIL COUPON

McGRAW-HILL BOOK CO., 330 W. 42 St., NYC 18

Send me Abbott's NATIONAL ELECTRICAL CODE HANDBOOK for 10 days' examination on approval. In 10 days I will send $4.00 plus a few cents postage, or return the book postpaid. (Postage paid on cash orders.)

Name .....

Address .....

City and State .....

Company .....

Position W-10-25-47

(For Canadian price, write McGraw-Hill Co. of Canada Ltd., 12 Richmond Street E., Toronto, 1.)

SLIDE VIEWER shows prospect planned lighting in color and three-dimensional effect

colored slides of local lighting installations. The viewer is small and compact. It can be carried easily and withstands ordinary handling. Room light does not interfere with its use. A compartment for the transparencies is contained in the plastic body of the viewer.

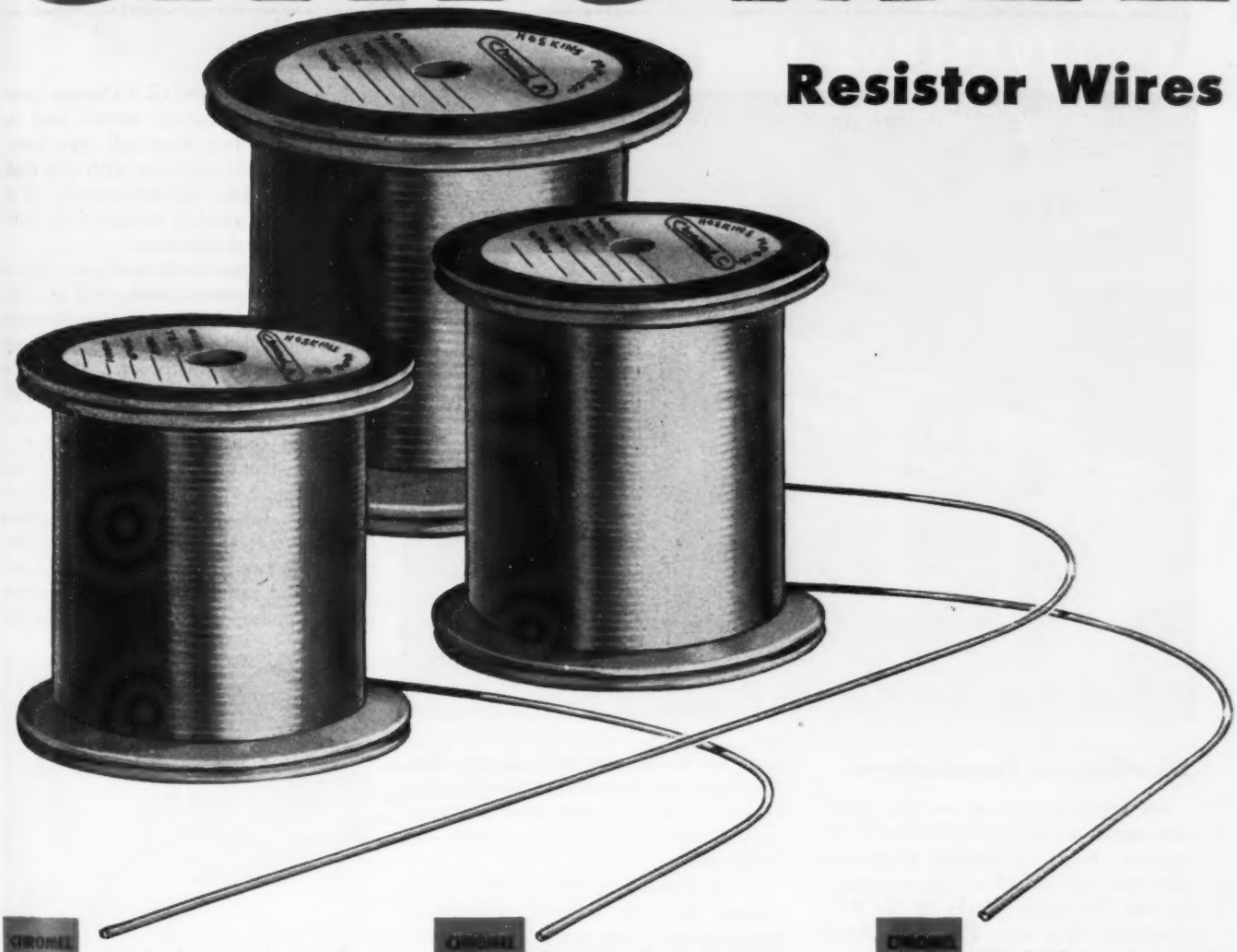
Installation photographs are taken by company photographers on 35-mm Kodachrome. The cost is low and the results far more effective than the usual black and white prints. Duplicates of the original slides are obtained. These provide each lighting man with a complete set of the slides available. Photographs are taken without added flash or floodlights. The finished picture is a true representation of the actual lighting. Close-up views of the lighting equipment are also used.

Use of Slides

In use, the slides of interiors and lighting effects that most nearly resemble the proposed installation are selected. The full color and three-dimensional appearance of these transparencies make suggestions to the prospect easily understood. Customer reaction has been unexpectedly enthusiastic. Since views of local installations are used, the prospect can visit the actual installation if further information is desired.

CHROMEL*

Resistor Wires



CHROMEL "A" Right for rough, tough applications. Possesses close-to-constant "hot" resistance between 700° and 2000°F., delivers full-rated power throughout its long and useful life. Resistivity: 650 Ohms per circular mil foot at 68°F.

CHROMEL "C" Developed especially to meet the requirements of medium temperature applications not exceeding 1700°F. Widely used for high resistances where only small space is available. Resistivity: 675 Ohms per circular mil foot at 68°F.

CHROMEL "D" Has highest temperature coefficient of resistance of all the CHROMEL Alloys. Normally used for temperatures up to 1200° to 1400°F. and higher under certain furnace atmospheres. Resistivity: 600 Ohms per circular mil foot at 68°F.

Points to remember when buying or specifying resistor wire: (1) Durable CHROMEL is the nickel-chromium alloy that first made electrical heating practical. (2) Its original famous formula remains basically unchanged despite 40 years of worldwide research. (3) It's as fundamental to electric heat as Ohm's law itself.

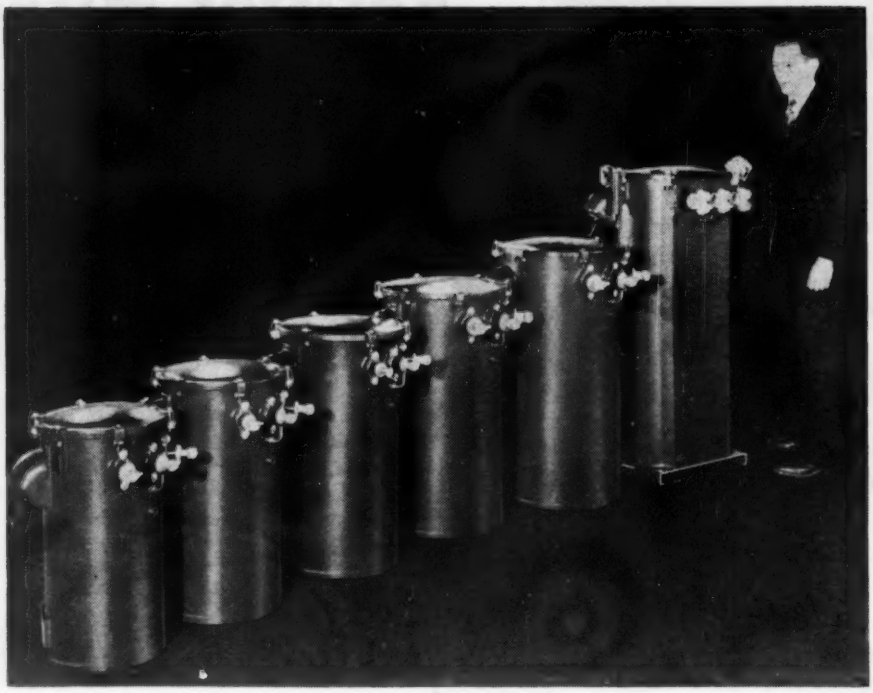
Our Catalog-M1 tells the complete technical story . . . want a copy?

Chromel
NICKEL | CHROMIUM WIRE

*TRADEMARK REG. U. S. PAT. OFF.

HOSKINS MANUFACTURING COMPANY • Detroit 8, Michigan

NEW EQUIPMENT



Distribution Transformers

AN IMPROVED LINE of smaller, lighter and more compact distribution transformers using preferred orientation electrical core steel has been announced by the Pittsburgh Works of the Allis-Chalmers Mfg Co. The new design represents a 17 to 46 percent saving in weight with corresponding reduction in size.

The line is engineered to meet all the recommendations included in the revised second report of the EEI-NEMA Joint Committee on the standardization of distribution transformers from 1½ to 100 kva, 2,400 through 15,000-v classes. The transformers are stated to represent the latest development in the electrical field as well as the latest advancements in metal fabrication and welding.

Features of the new units include spray Bonderized steel tanks with machine-welded seams to insure permanent protection against leaks; high-voltage pockets fabricated from a single piece of special deep-drawing steel permanently welded to the tank wall; recessed tank bottoms to provide additional protection against rusting and mechanical damages in handling, and low-voltage bushings mounted with a gasketed joint which is held in compression by a pressed steel gasket ring. This ring can be easily removed at installation for replacement of l-v bushings, if necessary, without opening the transformer.

Other features include standard flat-slotted lugs on internal low-voltage leads which allow quick change from series to parallel or vice versa, the use of preferred orientation electrical steel for efficient core type construction, and re-design to reduce copper-to-oil temperature gradients to a minimum, resulting in better short time overload characteristics.

The improved spray Bonderized transformers are given three coats of quality paint, each of which is baked on separately. This provides protection against severe weather conditions, salt and corrosive acid atmosphere.

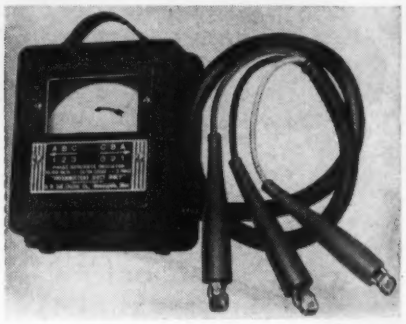
•

Phase Rotation Indicator

DESIGNED to operate between 50 and 600 volts, 25 to 120 cycles, and on 2-, 3- or 6-phase circuits, a phase rotation indicator has recently been introduced by the H. H. Sell Electric Co, 1907 Willow Ave, North, Minneapolis 11, Minn. The instrument, which indicates phase sequence, has a movement that consists of a 4-in., white enamel, aluminum disk mounted on a chrome steel shaft. This revolves within and is supported by two pivot bell type bearings. The unit operates with the disk vertical as well as horizontal. The black arrow painted on the disk indicates the phase rotation.

The movement is encased in a black wrinkle-finish metal case with a 1¾- by 3-in. unbreakable window through which the disk is seen. The entire unit is reported as dustproof. It has a heavy-duty, 3-ft, 3-wire cable with attached clips for connecting to conductors or equipment leads.

The instrument is designed for use on 3-phase, 2-phase 3-wire, and 6-phase circuits. When using on a 2-phase 3-wire circuit, the maximum voltage between the two outside wires should not exceed the rated 600 volts. To phase out a 6-phase device, the six terminals



should be grouped into two 3-wire groups with equal voltages between any pair of each group. The two groups should then be arranged with the same phase sequence, resulting in a phased and identified unit, and two 3-phase groups should form a 6-sided figure with proper voltages and polarity.

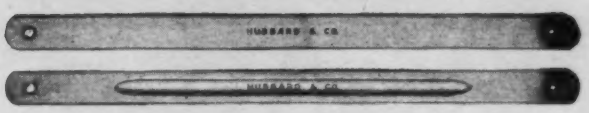
•

Selector Switches

SINGLE and double section circuit selector switches, useful where space is a factor, are being produced by P. R. Mallory & Co, Inc, Indianapolis, Ind. These rotary switches, identified as RSA-50 and RSA-60, have been designed for band and tone control switching in radio receivers and other electronic applications where medium and low torque indexing action is desired. The RSA-50 accomodates up to twelve terminals on either side of the section

UNSUNG HEROES OF POLE LINE CONSTRUCTION

Simple things, CROSS ARM BRACES, just a strip of flat steel with a hole punched in each end, but most important to a pole line. Hubbard Braces are fabricated from the best, new, open-hearth steel and all corners are rounded to protect linemen from sharp projections. For the engineer who wishes additional strength on the compression side of the arm, the ribbed brace is provided and offers approximately 25% added protection.

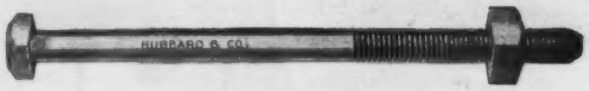


HUBBARD FLAT AND RIBBED CROSS ARM BRACES

HUBBARD ANGLE CROSS ARM BRACES, for heavy construction, are supplied in a range of spreads and drops to meet the requirements of any standard construction. Angle size runs from 1½ to 2-inches. At the pole attachment hole, the angle is so formed that wrench clearance is provided. Attachment is by ⅝-inch Machine Bolt at the pole and ½-inch Carriage Bolts at the arm.

HUBBARD ANGLE CROSS ARM BRACE

DRIVE POINT MACHINE OR CROSS ARM BOLTS are roll-threaded to provide a "finger-fit" for the full length of the thread. The "Drive Point" feature enables the bolt to be used as a drift pin for the alignment of holes slightly off center. This operation must be carried out with caution so as not to injure the threads. "Drive Point" also facilitates the application of nuts and allows bolts to be driven out of the pole for reclamation without injury to the threaded end. The major portion of Hubbard bolts of all types have this feature.



HUBBARD DRIVE-POINT CROSS ARM OR MACHINE BOLT

HUBEYE BOLTS are furnished for attachments of any kind where a thimble would normally be used. The eye of the bolt is drop-forged to a shape which provides a perfect "built in" thimble. Strand may be looped around the Hubeye with complete protection. Side walls of the eye retain the roundness of the strand. There is no possibility of kinks or strains at the loop. Hubeyes are a thoroughly tried and proven product.

HUBEYE DRIVE-POINT BOLT

STANDARD HUBBARD OVAL-EYE BOLTS are an old line item still much used in many sections. Hubbard Eye Bolts are all drop-forged with an eye that is stronger than the shaft of the bolt. Made from the best, new, open-hearth steel and Hubbard Double-Dip Hot Galvanized.

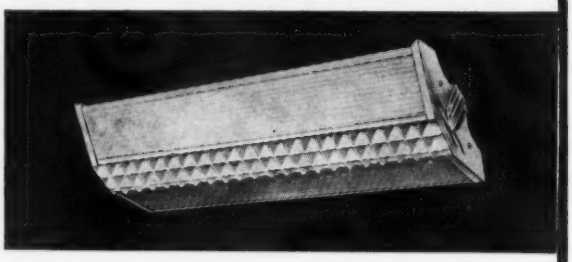
HUBBARD OVAL-EYE DRIVE-POINT BOLT

HUBBARD AND COMPANY

PITTSBURGH CHICAGO OAKLAND CALIF.

The VANGUARD

Newest SILV-A-KING Fluorescent Fixture . . . for commercial installations



No more dangerous high-ladder gymnastics . . . no more fancy tools . . . no more lacerated fingers or strong language! The Vanguard opens as easily, quickly, and safely as your fountain pen—for inspection, cleaning, or re-lamping.

For assurance of minimum maintenance time . . . Specify the Vanguard!

I. B. E. W., A. F. of L. • Listed by Underwriters' Laboratories, Inc.

Yours for the asking, "Vanguard" Bulletin No. 447FV

SILV-A-KING LIGHTING EQUIPMENT

BRIGHT LIGHT REFLECTOR COMPANY, INC.

Subsidiary of Bridgeport Pressed Steel Corp.

FAIRFIELD AT STATE • BRIDGEPORT 5, CONN.

and provides from two to six positions. The RSA-60 accommodates up to ten terminals on either side of the section and provides from two to five positions. The RSA-60 has a narrow section design said to be suitable for under-chassis mounting.

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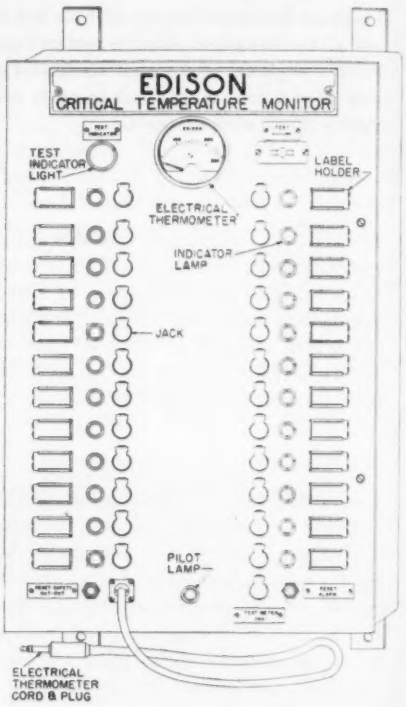
Temperature Monitor

To WARN when bearings start overheating is the function of a new automatic, multi-point bearing temperature



monitoring system recently developed by the Instrument Division of Thomas A. Edison, Inc, West Orange, N. J. The system is adapted both to principal equipment and auxiliaries in power generating stations, unattended and pipe line substations, pumping stations and general industrial operations. As many as 24 bearings can be monitored from each central control cabinet.

Electrical resistance bulbs are used. Each is 0.215 in. in diameter and mounted in a small hole drilled in each bearing. The temperature-sensitive bulb tips are located in direct contact with the bearing metal very close to the actual inner bearing surfaces.

The temperature of each bearing is checked automatically every 2 min. If, when checked, the temperature of any bearing exceeds an established maximum, an alarm is sounded to call an attendant. The overheated bearing is identified by an indicating lamp on the central control cabinet panel. Actual temperature of any bearing can be read by plugging into the appropriate jack an electrical thermometer which is

VENTILATED *Copper Angle Bus* provides Maximum Heat Dissipation

WHEN ANGLE SQUARE HOLLOW BUSSES are installed with surfaces at 45 degrees to the horizontal, a streamline effect is obtained in air movement around the angles. Rate of heat dissipation is thus increased, and correspondingly greater current density is achieved.

This factor, however, is but one of many which must be considered in selecting the most effective bus conductor shape. Location, space requirements or current characteristics may dictate the use of bars, tubes, channels or cables.

Regardless of *shape* decided on, the *metal* to use is *copper*. Combining high thermal and electrical conductivity with strength, toughness and corrosion resistance, copper is generally recognized as the most satisfactory bus material.

Anaconda Copper Bus Conductors are furnished in any of the shapes listed. For detailed information, consult our Technical Department, or write for Publication C-25. 47161

BARS require minimum space, may be bent or twisted, connected to apparatus without special joint preparation and in laminated construction have unlimited d.c. capacity.

TUBES provide the highest bus conductor efficiency at a.c. frequencies, have greater rigidity, and may be oil or water cooled.

CHANNELS have large surface area, reduce temperature rise, provide greater rigidity than tubes for long runs and have flat surfaces for tap-off.

ANGLES for ventilated hollow busses have highest rate of heat dissipation, handle greater current density, but require more space for installation.

CABLES solve many problems in conducting extremely heavy currents in confined space or in connecting moving apparatus such as furnaces of the arc or resistance types.

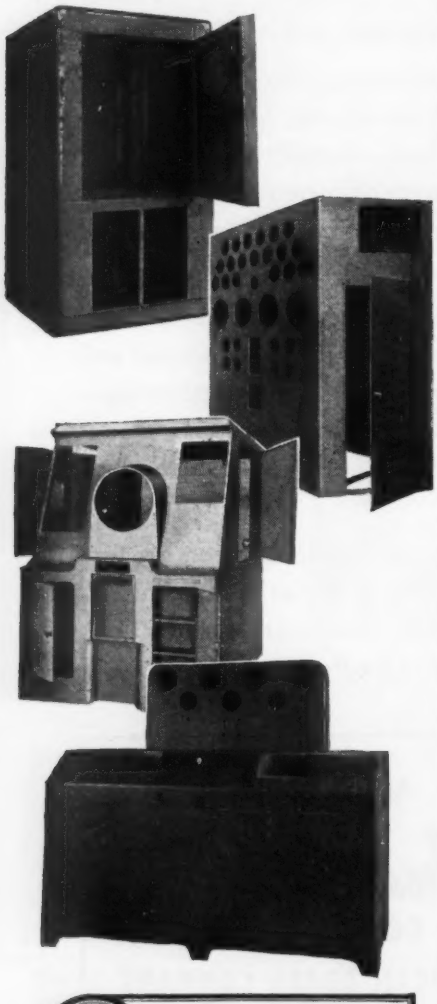
ANACONDA
from mine to customer

Anaconda
BUS CONDUCTORS

THE AMERICAN BRASS COMPANY
General Offices: Waterbury 88, Connecticut
Subsidiary of Anaconda Copper Mining Company
In Canada: ANACONDA AMERICAN BRASS LTD.
New Toronto, Ont.

OUR FIRST GOAL IN FABRICATING INSTRUMENT MOUNTING STRUCTURES

Artisans and engineers at Littleford understand *and meet* exacting requirements of manufacturers of electrical and hydraulic control equipment. Hence Littleford has become a foremost builder of such cabinets, panels, control boards, steel cubicles, mechanism boxes. Get structures right—get Littleford!



LITTLEFORD

LITTLEFORD BROS., INC.
421 E. Pearl St., Cincinnati 2, Ohio

built into the central control cabinet panel.

A modification of the system not only sounds an alarm at one established temperature, but also automatically shuts down the machine if a higher temperature is reached. With the modified system, the initial alarm can be transmitted to a central point any distance away.

In either system, checks of the actual temperature of each bearing may be made at any time at the control panel, on which facilities are also provided for the checking and testing of all circuits and alarms.

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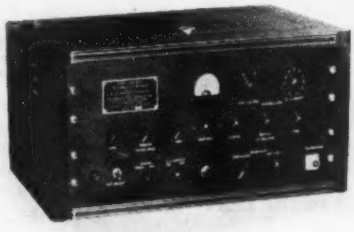
Thermistor Bridges

TWO NEW thermistor bridges have been announced by the Electronics Division, Sylvania Electric Products Inc,



500 Fifth Ave, New York 18, N. Y. They provide r-f power measurement up to two milliwatts at frequencies up to the shorter microwave regions.

Type TBN-7SE bridge is designed for continuous duty at normal laboratory ambient temperatures where measurement in S, X and K microwave bands may be made accurately with suitable r-f measuring heads. The bridge is independent of frequency but should be used with appropriate thermistor mount. Two-milliwatt scale sensitivity is essentially linear but a calibration curve is required for each r-f head used.

The instrument, designed for 100-130 v, 60-cycle input is rated at 25 w, weighs 14 lb and measures 8 in. x 8½ in. x 10 in. Tube complement includes one 6x5GT/G, two VR-105 and one VR-150.

Type TBN-6SE thermistor bridge (illustrated) which requires external oven and thermistor mount, contains a Wheatstone Bridge circuit with three precision resistor arms and externally mounted thermistor; a stabilized 2,000-cycle source for the bridge; stable d-c source for substitution measurement of r-f power; and an amplifier. It is independent of frequency and can be used as a balanced or unbalanced bridge providing accurate full scale meter readings from 25 microwatt to 2 milliwatts.

The instrument, designed for 115-v, 60-cycle input is rated at 150 w exclusive of external oven. It weighs 54 lb exclusive of oven and thermistor mount and measures 10¼ in. high, 21 in. wide

Sell more Light! with *COLOVOLT

Cold Cathode Lighting Equipment

Ravizza Supermarket, West Hartford, Conn.

Only Colovolt cold cathode, low voltage, ballast-type fluorescent lighting equipment can offer you all these extra advantages in good lighting.

- Lamp life rated at 10,000 hours
- Lamps guaranteed for one year
- Instant starting
- No blinking or flicker
- No starters or moving parts
- Lower maintenance cost

SEE OUR CATALOG IN SWEET'S

Architectural & Engineering Files for 1947.

Write for Cold Cathode lighting information for Lighting Salesmen, Contractors, Architects and Engineers.

*Trade Mark Registered U. S. Pat. Off.

GENERAL LUMINESCENT CORP.

680 S. FEDERAL STREET • CHICAGO 5, ILLINOIS

No. 1 of a series

from Western Precipitation Corporation — pioneers of the commercial application of COTTRELLS, *and now selling* COTTRELL *recovery equipment in all parts of the U. S. A. and foreign countries.*

Important points to know about COTTRELL *Electrical Precipitators*

A COTTRELL Electrical Precipitator is a major plant investment. Once installed it is operated over a period of many years, *thus multiplying year after year the benefits of top notch design and installation.*

And because of the many factors affecting the operating and collecting efficiency of a COTTRELL Precipitator, probably in no other field do the experience and "know-how" of the organization designing and installing the unit play a more important role in influencing the overall performance of the installation. That is why it is so important to remember this fact . . .

Western Precipitation Corporation is the organization that installed the first successful COTTRELL *Precipitator over 39 years ago, still operating efficiently . . . and has consistently developed new refinements, new techniques, new applications that today have made it world famous in the science of recovering dusts, fly ash, mists, fogs and other suspensions from gases.*

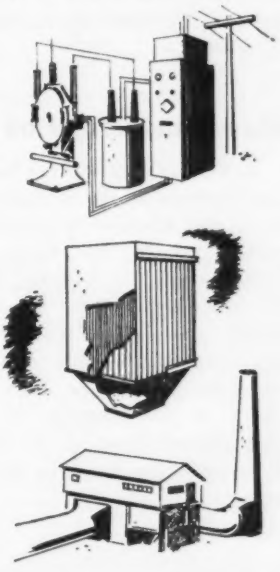
This is the first of a series of advertisements briefly outlining the important elements that go to make up a COTTRELL installation. Only long experience coupled with highest engineering ability, can assure the proper combination of these elements into a COTTRELL installation best suited to *your particular requirements*!

Basically, a Cottrell Precipitator consists of three major divisions each in turn consisting of many separate elements . . .

1. THE ENERGIZING SYSTEM, as its name implies, is the portion of the unit wherein the power is brought in, the voltage stepped up, then rectified to provide the unidirectional high voltage current supply for the Electrode System.

2. THE ELECTRODE SYSTEM consists of the high-tension ionizing electrodes and collecting electrodes through which the suspension-laden gas is passed to be cleaned. These electrodes can be of various designs, shapes and patterns and are equipped with various "rapper" arrangements which assist in keeping the electrodes clean of recovered materials.

3. THE HOUSING OR SHELL includes the structure containing the Electrode and Energizing Systems as well as the gas ducts and distributing system, the hoppers for receiving the collected material and other miscellaneous equipment.



Each of these three major divisions, together with their many individual parts, must be carefully engineered into ONE integrated and precisely-balanced unit to provide the successful and continuously-operating COTTRELL Precipitator. This series will take these major units apart to show in greater detail how the individual parts function and the varying types of design and construction. Watch for them.

10 COTTRELL ADVANTAGES

that make Cottrells unsurpassed for all types of recovery problems, hot or cold, wet or dry

1. **LOWEST DRAFT LOSS** — only a few tenths of an inch w. g.
2. **LOWEST POWER COST** — only ½ to 1 kwh. per 100,000 cu. ft. of gas cleaned.
3. **LOWEST MAINTENANCE COST** — all metal, few moving parts, no fire hazard.
4. **LOWEST LABOR COST** — operation can be fully automatic, if desired.
5. **LONGEST LIFE** — early Cottrell installations still operating after 39 years of continuous service.
6. **HIGHEST EFFICIENCY** — recovery efficiency approaches 100%, if desired.
7. **UNIVERSAL APPLICABILITY** — recover any suspension, solid or liquid — in any gas — over wide temperature ranges.
8. **ANY CAPACITY** — handle a few c.f.m. — or millions — with equal ease.
9. **MAXIMUM FLEXIBILITY** — readily adaptable to varying installation requirements.
10. **LOWEST OVERALL COST** — cost less per year of service, less per ton recovered. Often pay for themselves in a few months — always within a few years.

WESTERN Precipitation CORPORATION

ENGINEERS, DESIGNERS & MANUFACTURERS OF EQUIPMENT FOR COLLECTION OF SUSPENDED MATERIALS FROM GASES & LIQUIDS

Main Offices: 1004 WEST NINTH STREET, LOS ANGELES 15, CALIFORNIA
CHRYSLER BLDG., NEW YORK 17 • 1 LaSALLE ST. BLDG., 1 N. La SALLE ST., CHICAGO 2 • HOBART BUILDING, SAN FRANCISCO 4, CALIFORNIA
PRECIPITATION CO. OF CANADA, LTD., DOMINION SQ. BLDG., MONTREAL

Do You Have This Helpful COTTRELL Booklet? In 28 pages of interesting charts, illustrations and descriptive data, it answers many of the questions engineers ask about COTTRELL design and construction. Send for your free copy. Ask for Bulletin C103!

FOR
STRENGTH
AND
DURABILITY!
Silicon
BRONZE
BOLTS

Extra strength ... resistance to corrosion ... resistance to season cracking ... these are some of the qualities of Harper Silicon bronze fastenings which have led to their use by scores of power companies and electrical equipment manufacturers. These fastenings go into sub station assemblies, pot heads, pole line hardware, grounding equipment, and a host of other applications.

5200 ITEMS IN STOCK

Harper maintains a large and widely assorted stock of Silicon bronze bolts, nuts, screws, washers, and rivets. Moreover, similar stocks are maintained in brass, naval bronze, copper, Monel and stainless steel. Ask for summarized catalog.

ASK HARPER ENGINEERS

Harper engineers specialize in the manufacture and use of non-ferrous and stainless fastenings. Submit your fastening problems to them.

The H. M. HARPER COMPANY
2611 FLETCHER STREET
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Branches or representatives in principal cities

HARPER
Chicago

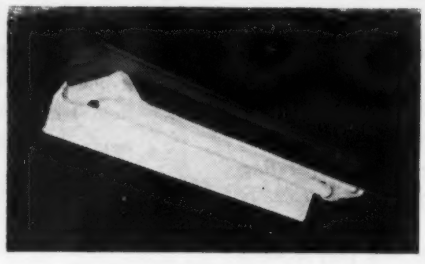
EVERLASTING FASTENINGS

and 15 in. deep. Tube complement includes seven 12J5, three 6Y6G, two 5U4G, three 12SH7 and two VR-90.

•

Industrial Lighting Unit

THE RD-80 UNIT, announced by Holdenline Co, 2301 Scranton Rd, Cleveland, is a new addition to their



Chan'l-Run industrial fluorescent fixtures. Features are internally mounted ballast, the new GE turret sockets, and enlarged wireway for continuous runs.

This new unit will be furnished with vitreous porcelain enamel reflector, designed to a shielding angle of 14 deg, a reflectance factor of over 79 percent and an over-all efficiency of above 80 percent. Watch-dog or No-Blink starters will be standard equipment.

•

Hard-Surfacing Electrodes

A NEW ELECTRODE for hard-surfacing applications where resistance to impact, wear, and abrasion is required has been announced by the Electric Welding Division of the General Electric Co, Schenectady, N. Y. Designated type W-94, the new electrode will work harden to over 50 Rockwell C. It operates on a-c or d-c reverse polarity. W-94 is available in 14-in. lengths, with diameters of $\frac{1}{4}$, $\frac{5}{32}$, $\frac{3}{16}$ and $\frac{1}{8}$ in. It is packaged in 50-lb standard packages.

•

A-C Generator

UTILIZING permanent magnets, an a-c generator which was developed during World War II for the U. S. Army is now in commercial production by Kober Electric Co, Arlington, Va.

The machine is shielded to avoid loss of magnetism and is said to be free of radio interference. Other features are: explosion-proof; fast recovery of terminal voltage after removal of overload and short-circuit; output voltage practically independent of temperature.

The generator is available in 60-cycle and 400-cycle types, single-phase and 3-phase; and in capacities ranging from 300 to 30 kw. It is adapted to outboard mounting. For applications which re-

Property
Appraisals

HERE'S an appraisal available for *any* situation—to meet the needs of buyer or seller. In one convenient package you can get any of the following features:

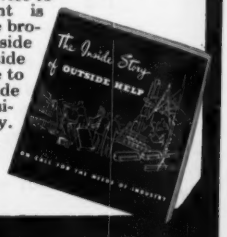
Inventory of physical properties; inventory priced at original, historical or current costs; studies of depreciation and reserve requirements.

Studies of intangible values; business value based on earnings and market value of income, operating costs, price and economic trends.

Assistance in mergers, consolidations, condemnation and severance damage matters; allocation of properties, operating costs and revenues for inter-company purposes.

EBASCO specialists include experienced engineers, accountants, financial, rate and other experts.

A complete outline of EBASCO'S individualized service to top-management is contained in the brochure "The Inside Story of Outside Help"—a guide to successful outside help in your business and industry. Your copy on request.



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Take a tip from a PWC Cord Set

A new, different and vastly better cord set. Flex it, twist it, use it, abuse it. It won't crack, fray or rot... isn't harmed by oils, greases, acids or most other chemicals . . . doesn't deteriorate with age.

We make them by the thousands for the country's top appliance manufacturers and leading electrical distributors—all types of flexible cords—parallel, light, medium and heavy-duty jacketed types—with standard or special plugs, receptacles or grommets molded on. Chances are there's one in your own office or home. Look for the letters PWC on the plug like that in the illustration. Note the cord's high luster, smooth, abrasion-resistant, easily cleaned finish . . . its attractive, permanent color and relatively small diameter, its flexibility.

Tailor-made, for every application, special electrical, chemical and physical characteristics are engineered into all PWC products . . . flexible cords, multiple conductors, telephone wires, radio wires, power cable, building wire, apparatus and machine tool wire, coaxial cable, shielded cables, special purpose wire and cable.

Send us your requirements and let us show you the gains from using PWC-engineered products. Our production facilities are geared to meet your needs.

PLASTIC WIRE & CABLE CORP.

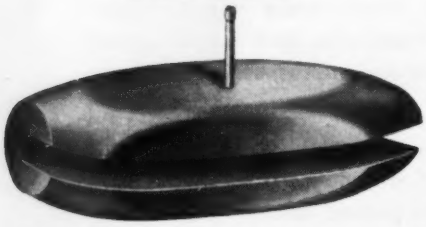
World's leading exclusive manufacturer of plastic insulated wire and cable

407 East Main Street, Jewett City, Conn.

PWC MEANS 10 WAYS BETTER

1. Superior dielectric strength.
2. Can't fray, crack or rot.
3. Low moisture absorption.
4. Greater mechanical strength.
5. Higher abrasion resistance.
6. Flexible over wide temperature range.
7. High chemical resistance.
8. Wide range of permanent, gem-like colors.
9. Non-combustible.
10. Lasting appearance.

THE NEW GUARD THAT HAS BECOME SO POPULAR



Flexibal

The GUARD that gives with the GUY

Literally a string of pillows, the Overton-Flexibal Guy Guard cushions the shock. It is the only guard that gives with the guy. No other type is so easy to handle, so simple to install. None other is so effective in cutting down losses. Nothing ever puts it out of commission. And they cost less! Separate spindles, smoothly shaped, are made of hard wood and aluminum-painted for greatest visibility and long life. Adjustable to any length in 6-inch steps. 5-6-7-8 foot lengths boxed for immediate shipment, — no waiting. Modernize your guy wire guards now, — you'll never go back to the old rigid style once you try Overton-Flexibal. Field-tested for years in thousands of locations.

AVAILABLE NOW, AND AT ALL TIMES

PACKAGED FOR EASY HANDLING AND STORAGE

Send for Free Sample

Flexibal GUY GUARD
is produced solely by
S.E. OVERTON CO.
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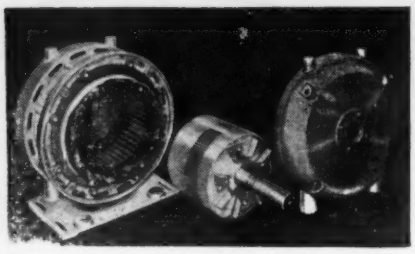


quire control of terminal voltage, an automatic integrally mounted voltage compensator is available. Maintenance is stated to be reduced by elimination of such items as exciters, slip rings, commutator and brushes.

•

Sequence Changers

TYPE HR alternator, also known as sequence changers, are electrically operated, fully automatic and are a product of Automatic Control Co, 1005 University Ave, St. Paul 4, Minn. They are used to automatically transpose the starting sequence of any pair of electrically operated units such as pumps, blowers, air compressors or other devices controlled by magnetic starters or two-wire circuits.

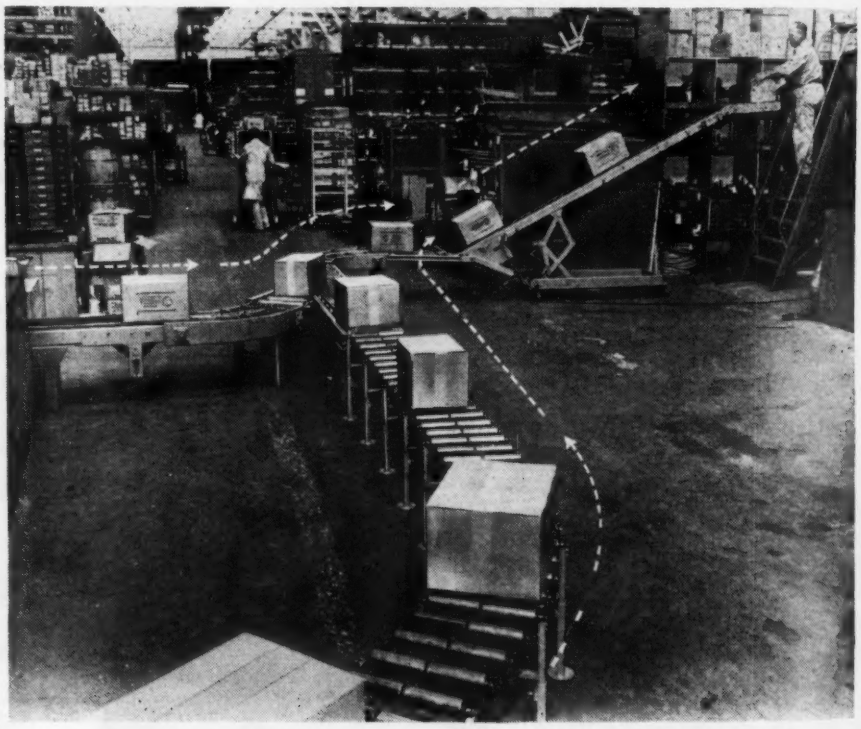
Pilot devices may be any single-pole pressure switches, float switches, thermal switches or other two-wire control devices. Pushbutton stations of the maintained contact type may also be used.

The alternator is said to require no auxiliary contact for its operation. No phasing out of operating units or control devices is reported necessary.

Used with a single pilot device the sequence changes on each successive closing of the pilot device will cause first one unit and then the other to operate, and thereby equalize the wear on the units. The alternator when used with two pilot devices not only equalizes wear by transposing starting sequence, but also permits supplementary stand-by operation of the second unit, whichever one may be second on that cycle.

Automatic sequence changers to electrically change the starting sequence of either three or four circuits are also available.

• • •



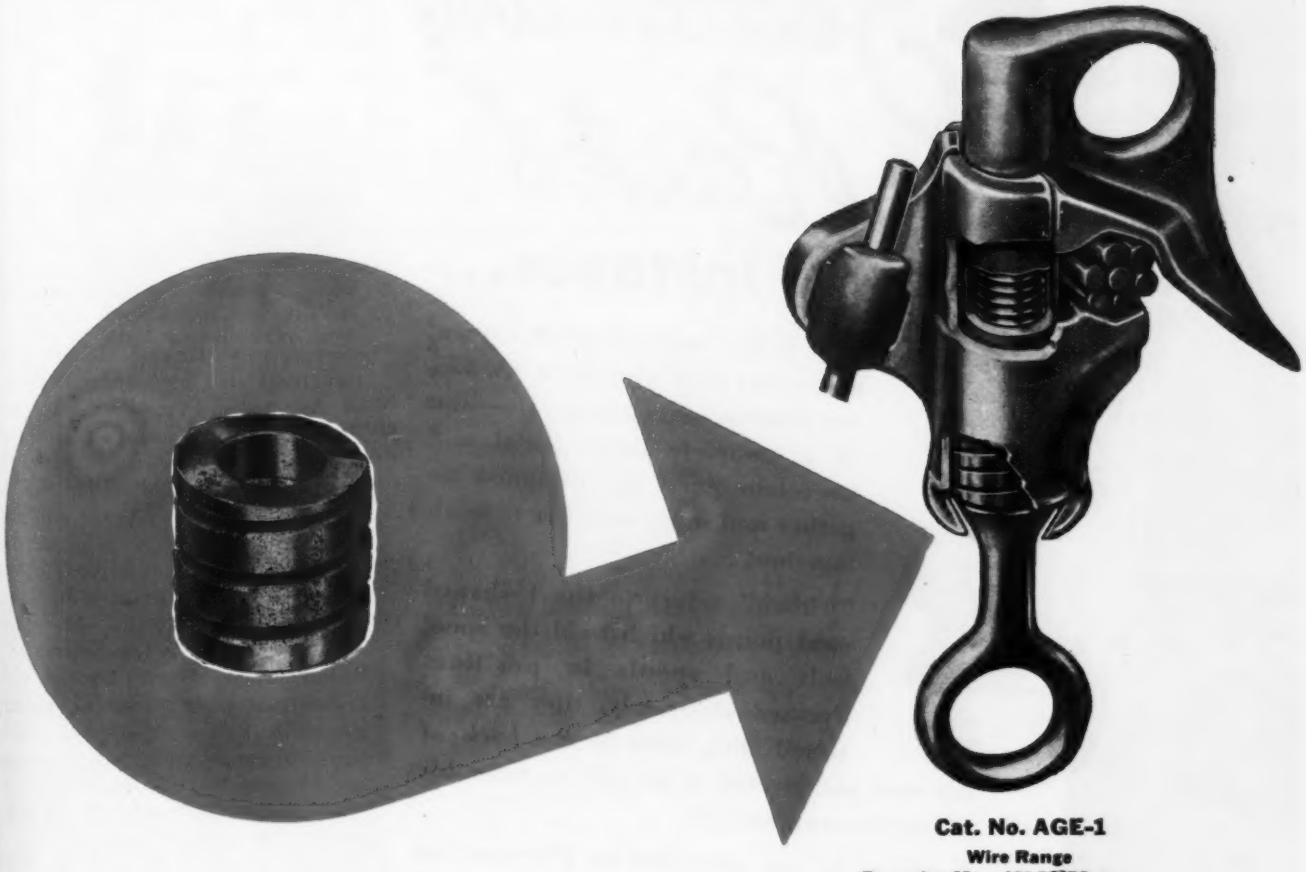
Conveyor System

A PORTABLE power conveyor system which can be set-up or disassembled quickly to handle loads up to 100 lb per ft has recently been developed by Food Machinery Corp, Riverside, Calif. Termed the "FMC Unitized Portable Power Conveyor System," the material handing equipment is built around a basic power unit made up of a standard 10-ft straight section powered by a ½-hp slow-speed motor. This unit combines with various accessories and with the company's Accordion gravity conveyor. Accessories include 90-deg power turns, automatic power conveyor intersection, piling conveyor base, power feed attachment, and gravity take-off attachment.

For the simple job of loading or unloading a truck, the portable unit is assembled as a stacking or piling conveyor. For more complicated problems,

FARGO

The spring makes the difference!



Cat. No. AGE-1

		Wire Range
Run wire	Max.	250 MCM or 2 ACSR plus armor
	Min.	#6 sol. copper
Tap wire	Max.	#2/0 str.
	Min.	#8 str.

YES—this clamp is different because the built in spring makes up for variables caused by fault currents, atmospheric changes, varying loads and our old friend—the "relaxation" or "flow" of copper.

The spring too, makes the clamp vibration proof as well as compensating for the different torque linemen use in tightening any bolt or clamp.

For aluminum connections the clamp is available in both electro-zinc plated bronze and all aluminum alloys.

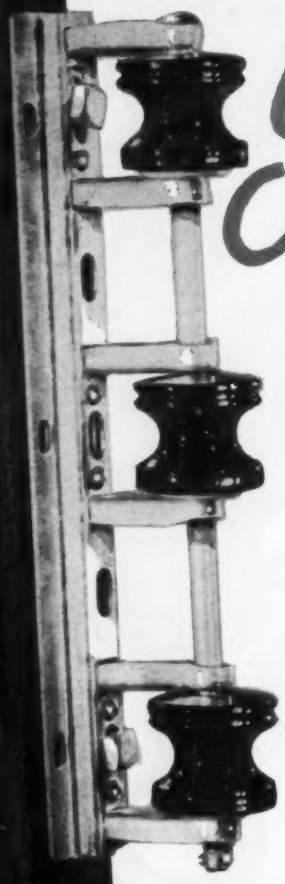
DISTRIBUTED BY

LINE MATERIAL COMPANY MILWAUKEE, WISCONSIN

FARGO MFG. COMPANY INC.

POUGHKEEPSIE, N. Y.

Look to Locke for Distribution Materials...



Secondary Racks

for instance...

Here is the Locke No. 0738 U-thru secondary rack with three No. 355 wet process porcelain spools—one of a complete line. Metal and porcelain parts are designed together and made together to work together.

"U-thru" refers to the U-shaped steel points which hold the spool bolt and spools in position. Formed separately, they are inserted thru slots in the back of the rack and riveted to provide an assembly of maximum strength.

Locke racks are protected by *Permazinc* — Locke's *Quality Controlled* double hot-dip galvanizing — for extra years of dependable performance.

Complete lines of distribution materials are maintained in six Locke regional warehouses and in most distributors' stocks. Call in your Locke representative.

Depend on Locke for Quality Controlled distribution materials—pole line hardware and insulators. One order covers both.

Locke **POLE LINE HARDWARE and INSULATORS**

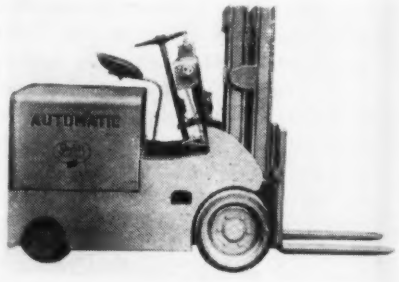
LOCKE INSULATOR CORPORATION • BALTIMORE 3, MD.

all units can be combined to operate from several different floor levels with all conveyor lines feeding into one main conveyor line.

•

Fork Truck

CAPABLE of tiering to truck and trailer ceilings as low as 68 in. and yet offering a total lift to 100 in., for



storage area stacking, a new electric fork truck has been added to the line of Automatic Transportation Co, 149 West 87th St, Chicago, Ill. It is available in 2,000-, 3,000-, and 4,000-lb capacities and designed so that the driver can sit and drive it like an automobile.

The forks will lift to 52 in. before the telescopic action begins to extend the mast. This is possible by separate hydraulic rams.

A new feature is the Newmatic controller which operates as the electric counterpart of an automobile automatic gearshift. This is reported to eliminate tire slippage, enables even acceleration and reduces the peak-load on the electrical system by two-thirds. When the accelerator is depressed, the controller starts the truck in first speed and automatically passes through the faster speeds. Dead-man control and ease of mounting and dismounting from either side are other features.

•

Splicing Tape

A "SCOTCH" ELECTRICAL TAPE with Vinyl plastic backing has been designed to make the wrapping of wire splices a one-tape operation. The tape is a new product of Minnesota Mining and Manufacturing Co. Forest and Fauquier Sts, St. Paul 6, Minn., and is said to combine the electrical insulation of rubber tape and the mechanical protection of friction tape.

The product is weather-resistant, has a dielectric strength of 1,000 per mil, and has an elongation before break of over 100 percent, according to the manufacturer. It is thinner than either rubber or friction tape, thus is suitable for splices which must fit into small spaces. Thicknesses range from 7 to 12 mils. Colors are yellow, white and black.

NEWS ABOUT PEOPLE

Watters Named Executive of Niagara Falls Utility

Gustav F. Watters, assistant vice-president of Buffalo Niagara Electric Corp, Buffalo, has been elected executive vice-president and a director of the Niagara Falls Power Co. Mr Watters will have complete charge of all the activities of the company. No action was taken on a successor to President Paul A. Schoellkopf, who died this month.

Resident Manager Wilfred C. Stephens, Buffalo Niagara Electric Corp, will remain in Niagara Falls.

Mr Watters began his utility career

G. F. WATTERS

in 1935 in Buffalo in the appliance service department, and from 1935 to 1939 was located in Olean where he gained a broad background of experience in the operations of the company, working in the line department, substations, distribution planning and rural extension departments. In 1939 he was transferred to the commercial sales department in Buffalo in charge of commercial electric cooking, and in 1940 became assistant to the vice-president of the Niagara, Lockport & Ontario Power Co, now merged with Buffalo Niagara Electric Corp.

In 1942, Mr Watters enlisted in the Ordnance Department of the U. S. Army. He was discharged in 1945 with the rank of major.

•

▶ JOHN M. CAGE has joined the teaching staff of the school of electrical engineering, Purdue University, as professor of electrical engineering in charge of electronics. Professor Cage goes to the teaching staff at Purdue from the Raytheon Manufacturing Co where he was manager of industrial electronics in charge of engineering, sales and production of industrial equipment. He has served eight years in electronic research and development work with the General Electric Co and five years as a member of the faculty of the University of Colorado. He was connected with the Allis-Chalmers Manufacturing Co before becoming a member of the Raytheon organization. Professor Cage is a member of the American Institute of Electrical Engineers and the Institute of Radio Engineers.

•

Coffin Made Chief Engineer of Massachusetts Board

Samuel P. Coffin has been appointed chief engineer of the Massachusetts Department of Public Utilities, succeeding W. J. Keefe, resigned. Mr Coffin joined the commission's engineering department in 1931 after extended railroad engineering experience. In 1943 he was appointed senior rate engineer, and has been active in valuation work, operating studies, and many phases of utility regulation.

Mr Keefe recently resigned to take an executive position in the transit field.

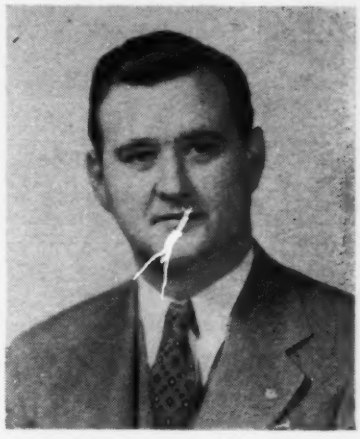
•

▶ JAMES W. ASMANN, senior operating engineer of the Cincinnati Gas & Electric Co, has been appointed assistant superintendent of electric operating. Mr Asmann started with the company in substation maintenance work in 1927. After serving in various engineering capacities, he was made operating engineer of the company in 1939.

▶ EDWIN BRAGUNIER has joined Westcott & Mapes, Inc, architects and engineers of New Haven, Conn., as electrical engineer, to undertake responsibility for the design work on generating plants, substations, transmission lines, and other electrical problems. Mr Bragunier has been associated with Ebasco Services, Inc, for the past eleven years on similar work.

W. J. Ridout Joins EEI As Rural Service Manager

William J. Ridout, agricultural engineer with the North Carolina Extension Service, has joined the Edison Electric



W. J. RIDOUT

Institute as rural sales manager. In his new position, Mr Ridout will supervise the farm electrification activities of the Institute, and will assist the various committees of the Institute's Farm Section.

A graduate of Virginia Polytechnic Institute, Mr Ridout joined the Kentucky & West Virginia Power Co as rural service engineer, and held this position until 1940, when he became power engineer for the East Tennessee Light & Power Co.

In 1941 Mr Ridout assumed the position of extension agricultural engineer for the South Carolina Extension Service at Clemson College, S. C. After his release from military service in 1945, he joined the North Carolina Extension Service at Raleigh, N. C., as extension agricultural engineer in charge of rural electrification.

As EEI's rural service manager, Mr Ridout succeeds Roy W. Godley, who recently joined the Kroger Co, Cincinnati, in a public relations capacity.

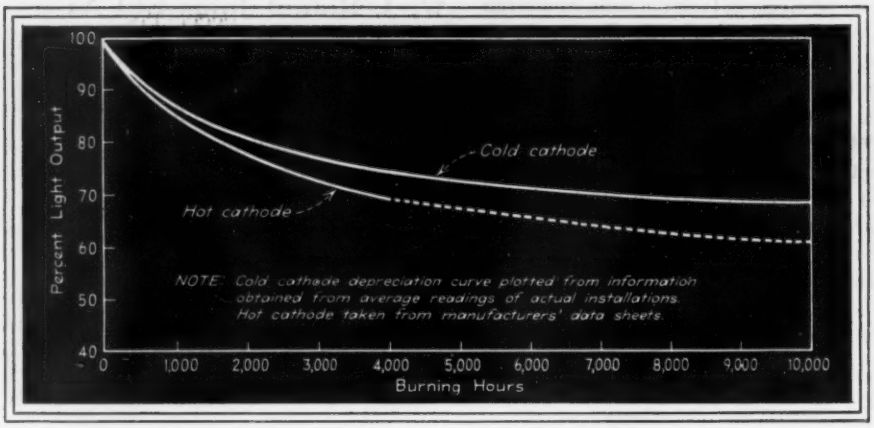
•

▶ MURRAY H. OWEN has been appointed manager of sales of the General Electric Co's wire and cable division. Mr Owen's new position includes his old duties as manager of sales of the York wire and cable section as well as the duties of

For ultimate economy

Specify **HAIRPINLINE**

Cold Cathode Fixtures



● One of the outstanding features of cold cathode lighting is the high efficiency of the lamp during its exceptionally long life. Five years of highly efficient lighting service with practically no maintenance is not uncommon for cold cathode lamps.

To illustrate this point note in the chart above the high efficiency of cold cathode lamps in actual tests made over a period of 10,000 hours.

Here's a record of a school installation that further proves the economy of cold cathode lighting. 472 lamps were installed and in a period of 4½ years only 8 units were replaced—three failed the work when installed—five were replaced after the first 100 hours. Thus after the first hundred hours there have been no replacements—maintenance is nil and the installation is still giving excellent lighting and perfect light distribution.

By test in several class rooms, cold cathode Hairpin type units, operating with a 120 MA/750 V ballast, showed the brightness of any surface in the peripheral field to be 48 times that of the task; in other words a ratio of 48 to 1, which is well within the limitation required.

Compare these records with your present lighting costs over a period of four or five years and you will see why cold cathode lighting is so economical in the long run.

The fixtures are simple—easily installed—require no reflectors.

Consult Illuminating Engineering Co. or its representative in your community for better lighting and lower ultimate lighting costs.

ILLUMINATING ENGINEERING *Company*

Designers and Manufacturers of Slimline and Cold Cathode Lighting Fixtures

2347 E. NINE MILE ROAD · · · HAZEL PARK, MICHIGAN

A. E. NEWMAN, formerly manager of sales of the Bridgeport wire and cable section, who has retired after 37 years of service. Mr Owen joined General Electric in Bridgeport in 1922.

•

Neblett Made Administrator, GE Nucleonics Project

R. S. Neblett, manager for the past two years of the federal and marine divisions, General Electric Co, has been

R. S. NEBLETT

named administrator of the company's Nucleonics Project, which consists of work on atomic energy for the U. S. Atomic Energy Commission, Dr Zay Jeffries, vice-president and general manager of the GE chemical department, has announced.

The GE Nucleonics Committee, which has administered the company's activities in this field for the past year, announced simultaneously that responsibility for contractual administration and negotiations in connection with the project is transferred to the chemical department. The committee will retain responsibility for general policies of administration and operation of the project. Operation of the Knolls Atomic Power Laboratory, now under construction, will remain under the GE Research Laboratory. The chemical department will retain responsibility for operation of the Hanford Engineer Works near Richland. Wash.

Mr Neblett named as his assistant Bruce R. Prentice, who has been serving as staff assistant on Nucleonics Projects work to H. A. Winne, GE vice-president in charge of engineering policy and chairman of the Nucleonics Committee.

Mr Neblett, who during the war worked closely with the U. S. Navy Bureau of Ships in expediting manufacture and delivery of geared-turbine propulsion sets for Navy ships, has been associated with the company since 1923. After completing the GE test course, he was assigned to the turbine division in

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1926. He became manager of sales of the Schenectady section in 1938, and assistant manager of the turbine division the following year. He was named assistant manager of the federal and marine divisions in 1943 and manager in 1945.

Following graduation from Kansas State College in 1930, Mr Prentice served as a student engineer on the test course, became a member of the advanced engineering program and subsequently an instructor in that program. In 1939 he was transferred to the aeronautics and marine engineering division and for the next seven years engaged in aeronautic and marine engineering work. During the war he also was active in the radar programs for the U. S. Army Air Forces. Early in 1946 Mr Prentice was transferred to the staff of the manager of engineering of the company's apparatus department, with responsibility for coordinating engineering on atomic power projects. Later that year he joined the engineering policy division of the executive department, as assistant to Mr Winne on atomic energy matters.

•

► ANDREW W. ROBERTSON, chairman of the board of directors of the Westinghouse Electric Corp, has been awarded the President's Certificate of Merit for services in behalf of the Navy's wartime shipbuilding program.

► GEORGE W. SCOTT has been elected vice-president and secretary, Hotpoint, Inc. He has held the latter position and that of treasurer since 1933. WALTER R. GRANT was elected to the treasurer's post relinquished by Mr Scott. Mr Grant formerly held a similar position with Locke Insulator Corp, Baltimore, Md., which like Hotpoint, is a General Electric affiliate.

► WILLIAM M. LEWIS, for many years district manager for the Consumers Power Co in Muskegon, has retired recently. Mr Lewis became manager of the company's properties in Muskegon almost 34 years ago, just after the local electrical properties had been taken over from the gas company by Consumers Power Co. During his entire public utility career, Mr Lewis has been active in association and civic work. He served as president of the Michigan Section of the old National Electric Light Association, now Edison Electric Institute, and was for years vice-president and director of the Greater Muskegon Chamber of Commerce. He was also one of the founders of the Greater Muskegon Industrial Foundation, Inc. an organization of which he is still the president, and which has been so suc-

cessful in obtaining new industries for Greater Muskegon. Almost as soon as Mr Lewis retired from Consumers Power, he was elected to fill a vacancy on the Muskegon City Commission and has just been named by city, county and school officials to head a citizens' committee for tax study and revision of the entire tax structure.

•

Westinghouse Makes Sales, Engineering Appointments

New assignments recently announced by the Westinghouse Electric Corp include the following:

Joseph F. Chalupa has been appointed manager of design engineering of the aviation gas turbine division, Lester, Pa. Mr Chalupa joined Westinghouse in 1930 at Philadelphia, where he was assigned to layout and design of steam turbines. He has concentrated on aircraft gas turbine engineering since the beginning of this activity by Westinghouse in 1941.

P. T. Lagrone has been named manager, customer section, central station sales department. Upon completion of the Westinghouse student course, Mr Lagrone worked in various headquarters sales departments on central station apparatus. He has also had utility experience with Arkansas Power & Light Co and with Mississippi Power & Light Co.

Frank E. Bodine has been appointed Pacific Coast manager of maintenance sales, with headquarters in San Francisco. Formerly sales manager for Westinghouse at Salt Lake City, Mr Bodine has served as sales manager at San Francisco since 1944. In his new duties he will serve the company's entire Pacific Coast district and will coordinate activities of headquarters, manufacturing and repair, engineering and service and other divisions of the company in the sale of renewal parts and shop repairs throughout the district.

Frederick S. Rowe, who joined the Westinghouse Lamp Division in Bloomfield, N. J., as a production clerk 34 years ago, has been appointed production manager of the division. Mr Rowe will guide production planning in the existing Lamp Division plants in Bloomfield, Belleville, Trenton, N. J., Fairmont, W. Va., and at the new plants being constructed in Little Rock, Ark., and Richmond, Ky.

Dr R. C. Mason has been named manager of the electro-physics department of the Westinghouse Research Laboratories, succeeding Gaylord W. Penney, who was recently appointed Westinghouse professor of electrical engineering at the Carnegie Institute of Technology. Dr Mason has been on

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leave of absence at the atomic energy project in Oak Ridge, Tenn., for the past year.

H. W. Lingenfelter, for 23 years a lighting engineer with Westinghouse, has been appointed manager of commercial, industrial, and floodlighting sales for the lighting division in Cleveland. Mr Lingenfelter goes to Cleveland after 13 years at the Westinghouse Minneapolis office.

Edward W. Gaughan, formerly assistant general appliance manager of the Westinghouse Electric Supply Co, has been appointed general farm sales manager. Mr Gaughan has been with the Westinghouse organization since 1919.

OBITUARY

Floyd F. McCammon

Floyd F. McCammon, vice-president and general superintendent of electrical operations of the Public Service Co of Colorado, died in Denver on September 20 after a brief illness. He was 57 years old.

Mr McCammon began his career in the public utility industry in 1916, when he became identified with the Denver Gas & Electric Light Co as a junior engineer. Upon his return from military service in World War I, he became an electric design and construction engineer. In 1920 he was appointed superintendent of the power sales department and eight years later was named assistant general superintendent of the operating department. In 1939 he was elected to the board of directors and the following year was appointed general superintendent of electric operations.

Mr McCammon was actively identified with various civic activities during his association with the company and was widely known in electrical engineering circles.

•

► HAROLD K. DOYLE, assistant to the president and a member of the board of directors of the Dallas (Tex.) Power & Light Co, died suddenly on September 27. Before his appointment as assistant to the president, Mr Doyle was operating superintendent of the company and prior to that time he was chief engineer. He joined the company in 1931 as distribution engineer. Mr Doyle was born at Pittsburgh, Pa., in 1899. He attended Carnegie Technological Institute and the University of Pittsburgh. Before joining the Dallas utility he was connected with the West Penn Power Co, Pittsburgh, and with Electric Bond & Share Co of New York. Mr

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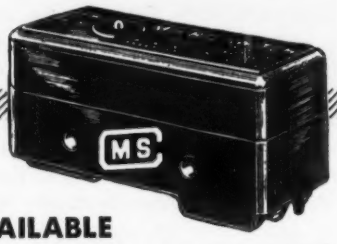

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Doyle was a fellow of the American Institute of Electrical Engineers and a past-chairman of the North Texas section.

► Paul Guercken, who retired in 1940 as European vice-president of the Westinghouse Electric International Co, died on October 12 in New York after a long illness. He was 76 years old. Born in Moscow, Mr Guercken was educated at the Alexandrovsky Commercial College and entered the employ of Westinghouse Electric in 1906. He was the resident agent for Westinghouse in Russia until 1918, when he came to the United States. In 1920 he went to London as Westinghouse agent for Scandinavian countries. It was in 1929 that he was appointed European vice-president, retiring at the end of 1940. Mr. Guercken became a British subject during the 1930's, but returned to the United States in 1943.

► Dr William D. Ennis, professor emeritus of economics of engineering at Stevens Institute of Technology, Hoboken, died on October 14 of a heart ailment at Suffern, N. Y. He was 70 years old. Educator, engineer and consultant, Dr Ennis retired three years ago as Humphreys professor of economics of engineering at Stevens because of ill health. At that time he terminated a 47-year career in the field. He was the author of six college text books, besides many professional papers and articles in technical magazines, and had been a speaker in frequent demand on engineering economics topics before a variety of organizations. He had been associated with the American Society of Mechanical Engineers since 1898 and was elected a fellow of the society in 1939. He was also a fellow of the American Association for the Advancement of Science and of the Royal Economic Society.

► Edward H. Richter, municipal lighting engineer of the Detroit Edison Co, died suddenly at New Orleans on September 17. Mr Richter had worked for the company for 33 years in the drafting, underground and system engineering departments. For the past several years he has been municipal lighting engineer. He was a member of the street and highway lighting committee of the Illuminating Engineering Society.

► Edward J. Muir, chief of the power contracts division of the Tennessee Valley Authority, died at Chattanooga on October 14 after a brief illness. He was 47 years old. Mr Muir had been identified with the TVA since 1934.

MANUFACTURERS & MARKETS

Expansion of Utility Sales Division Made by Hotpoint

To meet an increased need for closer cooperation with both merchandising and non-merchandising electric utility companies, Leonard C. Truesdell, vice-president of marketing for Hotpoint, Inc, has announced the appointment of A. W. Peterson, formerly Kansas City district sales manager, as western manager of utility sales for Hotpoint. A. H. Jaeger is eastern manager of utility sales.

Pointing out that the missionary work done by utility companies on all types of electric appliances is in a large measure, responsible for the high degree of consumer acceptance that electric refrigerators, ranges and freezers enjoy today. Mr Truesdell said, "our plans for increasing annual sales volume to $100 million are closely geared to the acknowledged merchandising facilities of these electric utility companies. With their large sales crews, advertising programs, store demonstrations, window and floor displays and cooking schools, the utilities provide the ideal springboard for transmitting a national merchandising program to the local level. . . ."

Concurrent with the announcement of Mr. Peterson's appointment, Mr Truesdell stated that Hotpoint is also stepping-up merchandising operations in the home laundry division. Sales of washers, ironers and clothes dryers will be increased under the same general program of completely planned work centers as under the Hotpoint plan of merchandising kitchen appliances. Asserting that planned work centers have not been exploited as fully in the home laundry field as they have for kitchen appliances, Mr Truesdell said, "our approach to the multiple unit sale of washers, ironers and clothes dryers is basically the same as the plan we followed in increasing kitchen appliance sales from one range or one refrigerator to four or five kitchen units. . ."

•

Adds Small Motors to Line

Leece-Neville Co, which has confined its activities to specialized electrical equipment for the automotive, aviation, marine and allied fields, has announced the addition of fractional hp motors to its line. Volume production is already under way on fractional hp a-c motors for oil burners and fractional hp d-c motors used in the automobile field, S. Floyd Stewart, executive vice-president, stated.

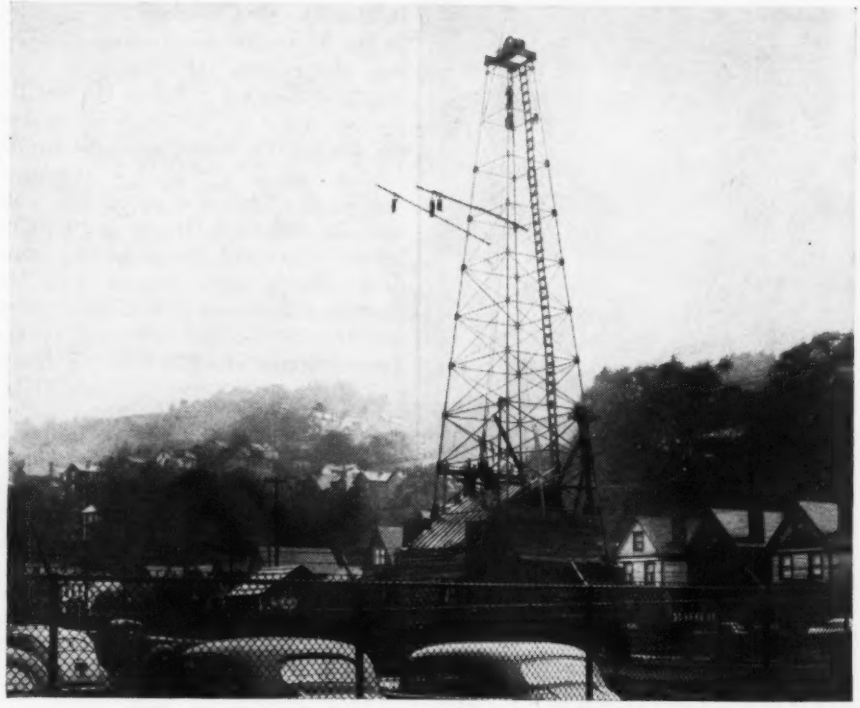
•

Producing Generating Equipment at Record Rate

Westinghouse Electric Corp is producing steam turbine generating equipment at a rate nearly double that of any previous year, Gwilym A. Price, president, stated recently.

"We expect to continue this high rate of production of electric power generating equipment through 1950," Mr Price stated.

Output of distribution transformers is running at a rate twice that of 1941 and meter production at more than 50 percent above 1941. Dollar volume of switchgear for controlling and regulating electric power is running 100 percent ahead of 1941.



WESTINGHOUSE Electric Corp is attempting to assure itself of an adequate gas supply by drilling a well on the grounds of its East Pittsburgh Works. Officials say that 500,000 cu ft a month will make them happy; and if they get water instead of gas, it can be used for cooling purposes at the copper mill

Healthy Business Prospects Seen for Allis-Chalmers

Healthy business prospects for the company are ahead, Walter Geist, president of the Allis-Chalmers Manufacturing Co, told the board of directors at a meeting held recently at Springfield, Ill.

"During the war," said Mr Geist, "we planned for a post-war employment increase of 50 percent which would bring our total employment to about 25,000. At the present time we are employing more than 31 000 and several of our plants, located in areas of tight labor markets, are seeking additional personnel."

"I have no crystal ball to foretell the future," he added, "but I know that there is a steady demand for every product we manufacture. In some cases we are still working to satisfy a pent-up demand from the war years.

"We have been happy to note an increasing spirit of cooperation between employee and management, which is certain to mean a more prosperous fu-

ture for the individual worker and the company," Mr Geist said.

A tour to review results of a $10,000,000 expansion program at the company's Springfield works, which is now employing approximately 4,100 persons, was made by the directors.

•

Manufacturers Make Sales Assignments

Electrical manufacturing companies have recently made the following appointments to their sales staffs:

ELECTRIC MACHINERY MFG CO, Minneapolis, Minn., has announced the establishment of new sales offices at Seattle, Wash., and Portland, Ore. A. C. Petrich, Garland-Affolter Engineering Corp, 532 First Avenue South, will handle the Seattle territory and George R. Schultz, Garland-Affolter Engineering Corp at 1233 N. W. 12th Ave, will handle the Portland territory.

ELECTRIC EQUIPMENT CO, Rochester, N. Y., has established a New York sales office at 224 East 38th St.

BAKER-RAULANG CO, Cleveland, has appointed J. G. Green Midwestern representative for the Baker Industrial Truck Division with headquarters at 407 South Dearborn St, Chicago.

REYNOLDS METALS CO, Louisville, has appointed Harry E. Weiler as manager of the Louisville district sales office, serving all Kentucky except Kenton and Campbell counties. In addition, that part of Indiana south of and including Knox, Daviess, Martin, Lawrence Jackson, Scott and Jefferson counties is served by this office.

•

Duro-Test Cuts Prices

Price reductions averaging 10 percent have been made by the Duro-Test Corp, North Bergen, N. J., on its line of Durolier fluorescent fixtures, Walter H. Simson, president, has announced. At the same time, Mr Simson stated, the company's fluorescent fixtures have been redesigned so as to provide more efficient distribution of light as well as greater beauty. Production facilities have been substantially increased. A plant for the manufacture of the company's new 8-ft Slim fluorescent fixture and for the germicidal unit just went into production at Cornwall, N. Y., Mr Simson declared.

•

Name-Finding Contest

Pennsylvania Transformer Co, Pittsburgh, is offering three cash prizes in a name-finding contest. The firm is seeking a descriptive name for a new distribution transformer embodying a new wound-core design with an inherent low-exciting current. Entries must be in by December 15.

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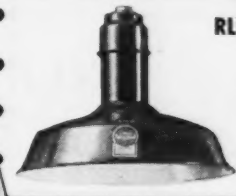

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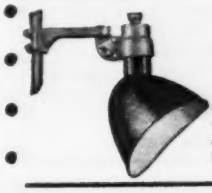

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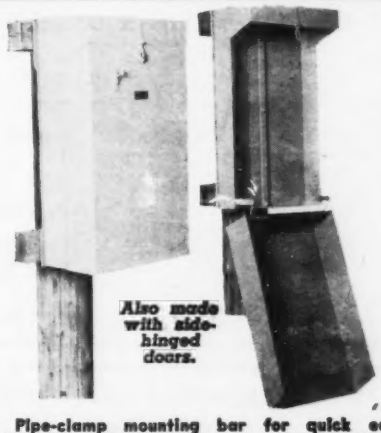

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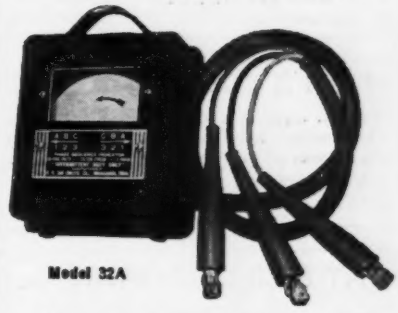

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